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of Oil & Gas
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Material Data Sheets for Piping and Valve Components



Revision history

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|---------|---------------|--|
| 2.0 | December 2018 | Second release |
| 1.1 | January 2017 | Correction to report reference on page 6 – S572 corrected to S-562 |
| 1.0 | December 2016 | First release |

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Foreword

This specification was prepared under a Joint Industry Project 33 (JIP33) "Standardization of Equipment Specifications for Procurement" organized by the International Oil & Gas Producers Association (IOGP) with support from the World Economic Forum (WEF).

This specification was developed on the basis of Norsok M-630, 6th edition, which is administered and published by Standards Norway on behalf of the Norwegian petroleum industry. Ten key oil and gas companies from the IOGP membership participated in developing this specification under JIP33 Phase 2 with the objective to leverage and improve industry level standardization for projects globally in the oil and gas sector. The work has developed a minimized set of supplementary requirements for procurement, with life cycle cost in mind, based on participating members' company specifications, resulting in a common and jointly approved specification, and building on recognized industry and/or international standards.

This specification has been developed in consultation with a broad user and supplier base to promote the opportunity to realize benefits from standardization and achieve significant cost reductions for upstream project costs. The JIP33 work groups performed their activities in accordance with IOGP's Competition Law Guidelines (November 2014).

Recent trends in oil and gas projects have demonstrated substantial budget and schedule overruns. The Oil & Gas Community within the World Economic Forum (WEF) have implemented a Capital Project Complexity (CPC) initiative which seeks to drive a structural reduction in upstream project costs with a focus on industry-wide, non-competitive collaboration and standardization. The vision from the CPC industry is to standardize specifications for global procurement for equipment and packages, facilitating improved standardization of major projects across the globe. Whilst individual oil and gas have been improving standardization within their own businesses, this has limited value potential and the industry lags behind other industries and has eroded value by creating bespoke components in projects.

This specification aims to significantly reduce this waste, decrease project costs and improve schedule through pre-competitive collaboration on standardization. This specification defines in the form of material data sheets (MDSs) and element data sheets (EDSs) the supplementary requirements to recognized industry and/or international material standards (the parent standards), which are indispensable for the application of this specification. Unless otherwise specified in the MDSs and EDSs, there are no supplementary requirements or modifications to the remaining clauses of the parent standards.

Following agreement of the relevant JIP33 work group and approval by the JIP33 Steering Committee, the IOGP Management Committee has agreed to the publication of this specification by IOGP. Where adopted by the individual operating companies, this specification aims to supersede existing company specifications for the purpose of industry-harmonized standardization.

This specification was first issued in December 2016 and re-issued with minor amendments in January 2017. This new revision introduces a number of key changes compared with previous revisions. In particular, the title of this specification has been revised to reflect that the scope has been extended to cover both piping and valves. Material data sheets existing in separate IOGP supplementary specifications for valves and piping have been consolidated into this specification to provide a consistent approach to procurement of materials. A new layout and numbering convention is used for all MDSs and EDSs and each data sheet covers a single product form. The range of applicability of the MDSs and EDSs has been extended by addressing specific minimum requirements for materials exposed to sour environments as defined in ISO 15156 /ANSI NACE MR0175 and ISO 17945 /NACE MR0103.

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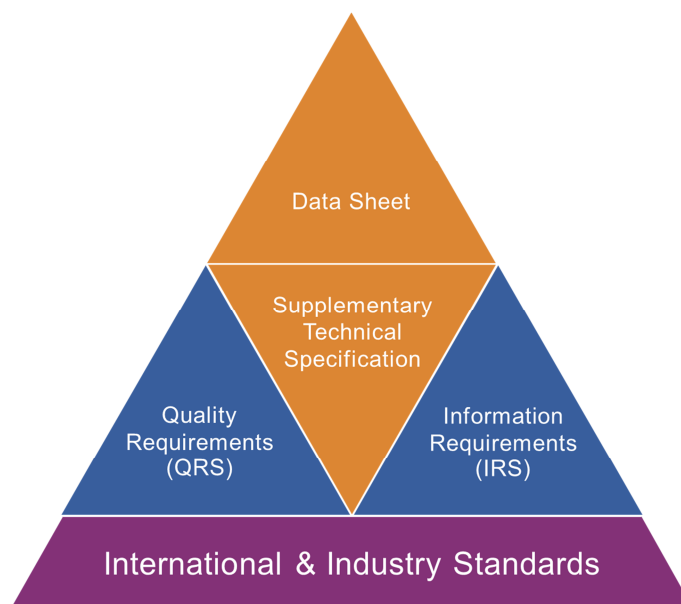
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Introduction

The purpose of this specification is to define a minimum common set of supplementary requirements for the specification for procurement of the most commonly used materials and to facilitate the manufacture of stock products to reduce cost and increase availability, for application in the petroleum and natural gas industries.

JIP33 standardized procurement specifications follow a common document structure comprising the four documents as shown below, which together with the purchase order define the overall technical specification for procurement.



JIP33 Specification for Procurement Documents Supplementary Technical Requirement

Quality and information requirements for the supply of piping and valve components are specified in the individual material data sheet rather than through separate quality requirements (QRS) and information requirements (IRS) specifications. Quality and information requirements for piping and valve components purchased as part of an equipment item are supplemented by the equipment QRS and IRS.

Unless defined otherwise in the requisition, the order of precedence (highest authority listed first) of the documents shall be:

- a) regulatory requirements;
- b) contract documentation (e.g. purchase order);
- c) user defined requirements (equipment data sheet, IRS, QRS);
- d) this specification;
- e) the parent standard.

This specification is not intended to preclude the use of alternative generic materials or grades within a referenced material standard. Where the use of alternative materials/grades are considered appropriate, the end user is responsible for specifying any additional requirements necessary to meet design and design code or specification.

1 Scope

This specification is a collection of material data sheets (MDSs) and element data sheets (EDSs) for the most commonly used components for piping systems and valves for Normal or Category D fluid service as defined in ASME B31.3.

NOTE The scope of S-563 is code independent and it is not restricted to piping designed to ASME B31.3.

Supplementary material requirements for services defined in ASME B31.3 as Category M fluid service, high pressure fluid service, elevated temperature fluid service, high purity fluid service, severe cyclic conditions, cryogenic service are excluded from the scope.

This specification addresses specific minimum requirements for materials exposed to sour environments as defined in ISO 15156 /NACE MR0175 and ISO 17945 /NACE MR0103. However, this specification does not provide guidelines for material selection and the selection of suitable materials for a specific service including any necessary additional material requirements remains the responsibility of the end (equipment) user.

Line pipe material for pipeline systems is outside the scope of this specification.

The material data sheets cover the following material types:

- Non-impact tested carbon steel;
- Impact tested carbon steel;
- Ferritic-austenitic stainless steel: types 22Cr duplex and 25Cr duplex;
- High alloy austenitic stainless steel: type 6Mo;
- Austenitic stainless steel: type 316/316L, type 304/304L;
- Copper-Nickel alloys: type 90-10 and aluminium bronze;
- Nickel alloys: type 625;
- Nickel bolting: type 625, 718;
- Precipitation-hardened stainless steel bolting: type 660;
- Titanium grade 2;
- High strength, low alloy steels.

The element data sheets address the following:

- Hard facing by weld overlay;
- Hard facing by thermal spraying;
- Electroless nickel plating;
- Corrosion resistant weld overlay;
- Solid tungsten carbide.

2 Normative references

The following normative references shall apply. For undated references, the latest edition of the document (including any amendments) shall apply.

| | |
|----------------------------|---|
| ANSI/MSS SP-55 | Quality Standard for Steel Castings for Valves, Flanges, Fittings, and Other Piping Components - Visual Method for Evaluation of Surface Irregularities |
| API SPEC 5L | Specification for Line Pipe. |
| API STD 6ACRA | Age-hardened Nickel-based Alloys for Oil and Gas Drilling and Production Equipment |
| ASME B16.34 | Valves - Flanged, Threaded, and Welding End |
| ASME BPVC Sec. V | Nondestructive Examination |
| ASME BPVC Sec. VIII Div.1 | Rules for Construction of Pressure Vessels |
| ASME BPVC Sec. IX | Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators |
| ASME BPVC Code Case 2120-1 | Nickel-Iron-Chromium-Molybdenum-Copper Low Carbon Alloy (UNS N08926) for Code Construction Section VIII, Division 1 |
| ASNT SNT-TC-1A | Recommended Practice No. SNT-TC-1A: Personnel Qualification and Certification in Nondestructive Testing |
| ASTM E10 | Standard Test Method for Brinell Hardness of Metallic Materials |
| ASTM E18 | Standard Test Methods for Rockwell Hardness of Metallic Materials |
| ASTM A29/A29M | Standard Specification for General Requirements for Steel Bars, Carbon and Alloy, Hot-Wrought |
| ASTM A105/A105M | Standard Specification for Carbon Steel Forgings for Piping Applications |
| ASTM A106/A106M | Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service |
| ASTM A182/A182M | Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High- Temperature Service |
| ASTM A193/A193M | Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications |
| ASTM A194/A194M | Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both |
| ASTM A216/A216M | Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service |
| ASTM A234/234M | Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service |

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|-----------------|---|
| ASTM A240/A240M | Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications |
| ASTM A269/A269M | Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service |
| ASTM A276/A276M | Standard Specification for Stainless Steel Bars and Shapes |
| ASTM A312/A312M | Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes |
| ASTM A320/A320M | Standard Specification for Alloy-Steel and Stainless Steel Bolting for Low-Temperature Service |
| ASTM A333/A333M | Standard Specification for Seamless and Welded Steel Pipe for Low-Temperature Service and Other Applications with Required Notch Toughness |
| ASTM A350/A350M | Standard Specification for Carbon and Low-Alloy Steel Forgings, Requiring Notch Toughness Testing for Piping Components |
| ASTM A351/A351M | Standard Specification for Castings, Austenitic, for Pressure-Containing Parts |
| ASTM A352/A352M | Standard Specification for Steel Castings, Ferritic and Martensitic, for Pressure-Containing Parts, Suitable for Low-Temperature Service |
| ASTM A358/A358M | Standard Specification for Electric-Fusion-Welded Austenitic Chromium-Nickel Stainless Steel Pipe for High-Temperature Service and General Applications |
| ASTM A370 | Standard Test Methods and Definitions for Mechanical Testing of Steel Products |
| ASTM E384 | Standard Test Method for Microindentation Hardness of Materials |
| ASTM A403/A403M | Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings |
| ASTM A420/A420M | Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Low-Temperature Service |
| ASTM A453/A453M | Standard Specification for High-Temperature Bolting, with Expansion Coefficients Comparable to Austenitic Stainless Steels |
| ASTM A479/A479M | Standard Specification for Stainless Steel Bars and Shapes for Use in Boilers and Other Pressure Vessels |
| ASTM A488/A488M | Standard Practice for Steel Castings, Welding, Qualifications of Procedures and Personnel |
| ASTM A494/A494M | Standard Specification for Castings, Nickel and Nickel Alloy |
| ASTM A516/A516M | Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service |
| ASTM A578/A578M | Standard Specification for Straight-Beam Ultrasonic Examination of Rolled Steel Plates for Special Applications |
| ASTM A694/A694M | Standard Specification for Carbon and Alloy Steel Forgings for Pipe Flanges, Fittings, Valves, and Parts for High-Pressure Transmission Service |

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| ASTM A696 | Standard Specification for Steel Bars, Carbon, Hot-Wrought or Cold-Finished, Special Quality, for Pressure Piping Components |
| ASTM A671/A671M | Standard Specification for Electric-Fusion-Welded Steel Pipe for Atmospheric and Lower Temperatures |
| ASTM A672/672M | Standard Specification for Electric-Fusion-Welded Steel Pipe for High-Pressure Service at Moderate Temperatures |
| ASTM A703/A703M | Standard Specification for Steel Castings, General Requirements, for Pressure-Containing Parts |
| ASTM A788/A788M | Standard Specification for Steel Forgings, General Requirements |
| ASTM A789/A789M | Standard Specification for Seamless and Welded Ferritic/Austenitic Stainless Steel Tubing for General Service |
| ASTM A790/A790M | Standard Specification for Seamless and Welded Ferritic/Austenitic Stainless Steel Pipe |
| ASTM A815/815M | Standard Specification for Wrought Ferritic, Ferritic/Austenitic, and Martensitic Stainless Steel Piping Fittings |
| ASTM A928/A928M | Standard Specification for Ferritic/Austenitic (Duplex) Stainless Steel Pipe Electric Fusion Welded with Addition of Filler Metal |
| ASTM A960/A960M | Standard Specification for Common Requirements for Wrought Steel Piping Fittings |
| ASTM A961/A961M | Specification for Common Requirements for Steel Flanges, Forged Fittings, Valves, and Parts for Piping Applications |
| ASTM A962/A962M | Standard Specification for Common Requirements for Bolting Intended for Use at Any Temperature from Cryogenic to the Creep Range |
| ASTM A985/A985M | Standard Specification for Steel Investment Castings General Requirements, for Pressure-Containing Parts |
| ASTM A988/A988M | Standard Specification for Hot Isostatically-Pressed Stainless Steel Flanges, Fittings, Valves, and Parts for High Temperature Service |
| ASTM A995/A995M | Standard Specification for Castings, Austenitic-Ferritic (Duplex) Stainless Steel, for Pressure-Containing Parts |
| ASTM A1014/A1014M | Standard Specification for Precipitation-Hardening Bolting (UNS N07718) for High Temperature Service |
| ASTM A1058 | Standard Test Methods for Mechanical Testing of Steel Products-Metric |
| ASTM A1082/A1082M | Standard Specification for High Strength Precipitation Hardening and Duplex Stainless Steel Bolting for Special Purpose Applications |
| ASTM B148 | Standard Specification for Aluminium-Bronze Sand Castings |
| ASTM B151/B151M | Standard Specification for Copper-Nickel-Zinc Alloy (Nickel Silver) and Copper-Nickel Rod and Bar |

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| ASTM B171/B171M | Standard Specification for Copper-Alloy Plate and Sheet for Pressure Vessels, Condensers, and Heat Exchangers |
| ASTM B265 | Standard Specification for Titanium and Titanium Alloy Strip, Sheet, and Plate |
| ASTM B338 | Standard Specification for Seamless and Welded Titanium and Titanium Alloy Tubes for Condensers and Heat Exchangers |
| ASTM B348 | Standard Specification for Titanium and Titanium Alloy Bars and Billets |
| ASTM B363 | Standard Specification for Seamless and Welded Unalloyed Titanium and Titanium Alloy Welding Fittings |
| ASTM B366/B366M | Standard Specification for Factory-Made Wrought Nickel and Nickel Alloy Fittings |
| ASTM B367 | Standard Specification for Titanium and Titanium Alloy Castings |
| ASTM B381 | Standard Specification for Titanium and Titanium Alloy Forgings |
| ASTM B443 | Standard Specification for Nickel-Chromium-Molybdenum-Columbium Alloy (UNS N06625) and Nickel-Chromium-Molybdenum-Silicon Alloy (UNS N06219) Plate, Sheet, and Strip |
| ASTM B444 | Standard Specification for Nickel-Chromium-Molybdenum-Columbium Alloys (UNS N06625 and UNS N06852) and Nickel-Chromium-Molybdenum-Silicon Alloy (UNS N06219) Pipe and Tube |
| ASTM B446 | Standard Specification for Nickel-Chromium-Molybdenum-Columbium Alloy (UNS N06625), Nickel-Chromium-Molybdenum-Silicon Alloy (UNS N06219), and Nickel-Chromium-Molybdenum-Tungsten Alloy (UNS N06650) Rod and Bar |
| ASTM A462 | Standard Specification for Forged or Rolled UNS N06030, UNS N06022, UNS N06035, UNS N06200, UNS N06059, UNS N10362, UNS N06686, UNS N08020, UNS N08024, UNS N08026, UNS N08367, UNS N10276, UNS N10665, UNS N10675, UNS N10629, UNS N08031, UNS N06045, UNS N06025, UNS R20033 Alloy Pipe Flanges, Forged Fittings, and Valves and Parts for Corrosive High-Temperature Service |
| ASTM B466/B466M | Standard Specification for Seamless Copper-Nickel Pipe and Tube |
| ASTM B467 | Standard Specification for Welded Copper-Nickel Pipe |
| ASTM B499 | Standard Test Method for Measurement of Coating Thicknesses by the Magnetic Method: Nonmagnetic Coatings on Magnetic Basis Metals |
| ASTM B564 | Standard Specification for Nickel Alloy Forgings |
| ASTM B571 | Standard Practice for Qualitative Adhesion Testing of Metallic Coatings |
| ASTM B578 | Standard Test Method for Microhardness of Electroplated Coatings |
| ASTM B602 | Standard Test Method for Attribute Sampling of Metallic and Inorganic Coatings |
| ASTM B705 | Standard Specification for Nickel-Alloy (UNS N06625, N06219 and N08825) Welded Pipe |

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| ASTM B733 | Standard Specification for Autocatalytic (Electroless) Nickel-Phosphorus Coatings on Metal |
| ASTM B834 | Standard Specification for Pressure Consolidated Powder Metallurgy Iron-Nickel- Chromium-Molybdenum (UNS N08367), Nickel-Chromium-Molybdenum-Columbium (Nb) (UNS N06625), Nickel- Chromium-Iron Alloys (UNS N06600 and N06690), and Nickel-Chromium-Iron-Columbium-Molybdenum (UNS N07718) Alloy Pipe Flanges, Fittings, Valves, and Parts |
| ASTM B861 | Standard Specification for Titanium and Titanium Alloy Seamless Pipe |
| ASTM B862 | Standard Specification for Titanium and Titanium Alloy Welded Pipe |
| ASTM C633 | Standard Test Method for Adhesion or Cohesion Strength of Thermal Spray Coatings |
| ASTM E165/E165M | Standard Practice for Liquid Penetrant Examination for General Industry |
| ASTM E562 | Standard Test Method for Determining Volume Fraction by Systematic Manual Point Count |
| ASTM F2329 | Standard Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners |
| ASTM F467 | Standard Specification for Nonferrous Nuts for General Use |
| ASTM F468 | Standard Specification for Nonferrous Bolts, Hex Cap Screws, and Studs for General Use |
| ASTM F788 | Standard Specification for Surface Discontinuities of Bolts, Screws, and Studs, Inch and Metric Series |
| ASTM F812 | Standard Specification for Surface Discontinuities of Nuts, Inch and Metric Series |
| ASTM G48 | Standard Test Methods for Pitting and Crevice Corrosion Resistance of Stainless Steels and Related Alloys by Use of Ferric Chloride Solution. |
| EEMUA Pub. 234 | 90/10 Copper Nickel Alloy Piping for Offshore Applications Specification |
| EN 10204 | Metallic products —Types of inspection documents |
| ISO 148-1 | Metallic materials - Charpy pendulum impact test - Part 1: Test method |
| ISO 3452 (all parts) | Non-destructive testing - Penetrant testing |
| ISO 3878 | Hardmetals - Vickers hardness test. |
| ISO 4624 | Paints and varnishes - Pull-off test for adhesion |
| ISO 4499 (all parts) | Hardmetals — Metallographic determination of microstructure |
| ISO 6506-1 | Metallic materials - Brinell hardness test - Part 1: Test method |
| ISO 6507-1 | Metallic materials - Vickers hardness test - Part 1: Test method |

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| ISO 6508-1 | Metallic materials - Rockwell hardness test - Part 1: Test method |
| ISO 6892-1 | Metallic materials -- Tensile testing -- Part 1: Method of test at room temperature |
| ISO 9001 | Quality management systems — Requirements |
| ISO 9606 (all parts) | Qualification testing of welders - Fusion welding |
| ISO 9712 | Non-destructive testing - Qualification and certification of NDT personnel |
| ISO 10474 | Metallic products — Inspection documents |
| ISO 11970 | Specification and qualification of welding procedures for production welding of steel castings |
| ISO 14732 | Welding personnel - Qualification testing of welding operators and weld setters for mechanized and automatic welding of metallic materials |
| ISO 15156-1 /NACE MR0175-1 | Petroleum and natural gas industries - Materials for use in H ₂ S-containing environments in oil and gas production - Part 1: General principles for selection of cracking-resistant materials |
| ISO 15156-2 /NACE MR0175-2 | Petroleum and natural gas industries - Materials for use in H ₂ S-containing environments in oil and gas production - Part 2: Cracking-resistant carbon and low-alloy steels, and the use of cast irons |
| ISO 15156-3 /NACE MR0175-3 | Petroleum and natural gas industries - Materials for use in H ₂ S-containing environments in oil and gas production - Part 3: Cracking-resistant CRAs (corrosion-resistant alloys) and other alloys |
| ISO 17637 | Non-destructive testing of welds - Visual testing of fusion-welded joints. |
| ISO 17781 | Petroleum, petrochemical and natural gas industries - Test methods for quality control of microstructure of austenitic/ferritic (duplex) stainless steels |
| ISO 17782 | Petroleum, petrochemical and natural gas industries -- Scheme for conformity assessment of manufacturers of special materials |
| ISO 17945 /NACE MR0103 | Petroleum, petrochemical and natural gas industries — Metallic materials resistant to sulfide stress cracking in corrosive petroleum refining environments |
| ISO 28079 | Hardmetals — Palmqvist toughness test |
| MSS SP-147 | Quality Standard for Steel Castings Used in Standard Class Steel Valves - Sampling Method for Evaluating Casting Quality |
| NACE TM0284 | Evaluation of Pipeline and Pressure Vessel Steels for Resistance to Hydrogen-Induced Cracking |
| NORSOK M-650 | Qualification of Manufactures of Special Materials |

3 Terms, definitions, acronyms and abbreviations

3.1 Terms and definitions

3.1.1 Shall

Verbal form used to indicate requirements strictly to be followed in order to conform to this specification and from which no deviation is permitted, unless accepted by the end (equipment) user.

3.1.2 May

Verbal form used to indicate a course of action permissible within the limits of this specification.

3.1.3 Carbon steel

Alloy of carbon and iron containing up to 2 % mass fraction carbon and up to 1.65 % mass fraction manganese and residual quantities of other elements, except those intentionally added in specific quantities for deoxidation (usually silicon and/or aluminium).

3.1.4 Low-alloy steel

Steel containing a total alloying element content of less than 5 % mass fraction, or steels with less than 10.5 % mass fraction chromium, but more than that specified for carbon steel.

3.1.5 Stainless steel

Steel containing ≥ 10.5 % Cr (by mass), possibly with other elements added to secure special properties.

3.1.6 Austenitic stainless steel

Stainless steel whose microstructure at room temperature consists predominantly of austenite.

3.1.7 Stainless steel types 304 and 316

Austenitic stainless steel certified to meet both 304/304L or 316/316L properties.

3.1.8 Stainless steel type 6Mo

Austenitic stainless steel alloys with 6 % Mo and PREN ≥ 40.0 .

3.1.9 Stainless steel type 22Cr duplex

Ferritic-austenitic stainless steel alloys with $30.0 \leq \text{PREN} < 40.0$ and Cr ≥ 19 % (by mass).

3.1.10 Stainless steel type 25Cr duplex

Ferritic-austenitic stainless steel alloys with $40.0 \leq \text{PREN} < 48.0$, often referred to as "super duplex".

3.1.11 Martensitic stainless steel

Stainless steel whose microstructure at room temperature consists predominantly of martensite.

3.1.12 Stainless steel type 13Cr

Martensitic stainless steel alloys with nominal 13 % Cr (by mass).

3.1.13 Precipitation-hardened stainless steel

Stainless steel with a high strength resulting from the precipitation of intermetallic compounds by a final heat treatment.

3.1.14 Nickel alloys

Metallic material in which nickel is the major element.

3.1.15 Pilot casting

Casting made and tested as part of the initiation and development of the production method such as the first casting from a new or modified pattern produced using identical foundry practices as the production castings it is intended to represent.

3.1.16 Nominal pipe size

Numerical designation of size in inches which is common to components in piping systems.

3.1.17 End (equipment) user

Company or organization (normally an oil company) that is responsible for the operation of an installation/facility and its component (e.g. piping, valve, etc.).

3.1.18 Purchaser

Party which purchases a product from a manufacturer. In the context of this specification, an oil company, the contractor or the buyer are purchasers.

3.1.19 Manufacturer (material)

Party, including subcontractors, which carries out operations (e.g. forming, heat treatment, welding, etc.) that affect the material properties of the finished product.

3.1.20 Quality specification level (QSL)

Level defining the extent of control activities, typically including verification, inspection and testing to be undertaken by supplier to demonstrate conformance with requirements based on determination of service risk (e.g. on the basis of pressure class, material, valve size and service) or obligations.

3.2 Acronyms and abbreviations

The following acronyms and abbreviations apply for this specification and are presented alphabetically.

| | |
|------|---|
| ACCP | ASTN Central Certification Program |
| ANSI | American National Standards Institute |
| AOD | argon oxygen decarburization |
| API | American Petroleum Institute |
| ASNT | American Society for Nondestructive Testing |
| ASTM | American Society of Testing and Materials |
| ASME | American Society of Mechanical Engineers |
| BPVC | boiler and pressure vessel code |
| CE | carbon equivalent ($\% C + \% Mn / 6 + (\% Cr + \% Mo + \% V) / 5 + (\% Ni + \% Cu) / 15$), with chemical element concentration expressed in mass fraction percent. |

| | |
|--------|--|
| CLR | crack length ratio |
| CSR | crack sensitivity ratio |
| CTR | crack thickness ratio |
| DN | nominal diameter |
| EBW | electron beam welding |
| EDS | element data sheet |
| EEMUA | Engineering Equipment & Materials Users Association |
| EN | European Norm (standard) |
| FCAW | flux-cored arc welding |
| GTAW | gas tungsten arc welding |
| HAZ | heat-affected zone |
| HBW | Brinell hardness with Tungsten ball |
| HIC | hydrogen-induced cracking |
| HIP | hot isostatic pressing |
| HR | Rockwell hardness |
| HRB | Rockwell hardness, B scale |
| HRC | Rockwell hardness, C scale |
| HV | Vickers hardness |
| HVOF | high velocity oxygen fuel |
| ISO | International Organization for Standardization |
| LBW | laser beam welding |
| MDS | material data sheet |
| MPCR | manufacturing procedure conformity record |
| MPS | manufacturing procedure summary |
| MSS | Manufacturers Standardization Society |
| MT | magnetic-particle testing |
| NACE | National Association of Corrosion Engineers |
| NDT | non-destructive testing |
| NORSOK | Norsk Søkkel Konkuranseposisjon (the Norwegian shelf's competitive position) |
| NPS | nominal pipe size |
| OD | outer diameter |
| PREN | pitting resistance equivalent number ($\%Cr + 3.3 \times \% (Mo + 0.5W) + 16 \times \%N$), with chemical element concentration expressed in mass fraction percent. |
| PSL | product specification level |
| PT | penetrant testing |
| PTAW | plasma transfer arc welding |
| PWHT | postweld heat treatment |
| QL | quality level |
| QSL | quality specification level |

| | |
|------|----------------------------------|
| QTR | qualification test record |
| RT | radiographic testing |
| SAW | submerged arc welding |
| SMAW | shielded-metal arc welding |
| SMYS | specified minimum yield strength |
| UNS | unified numbering system |
| UT | ultrasonic testing |
| VT | visual testing |
| WC | tungsten carbide |

4 Material and element data sheets

4.1 General

The material data sheets (MDSs) are collated in Annex A. They define applicable options and/or requirements that supplement or amend the referenced material standard or specification. The material shall be delivered in accordance with the standard specification referenced in the MDSs including any additional requirements specified therein. Unless otherwise specified in the MDSs, all the requirements of the referenced standard specification shall apply. The latest issue of the referenced standard specification at the time of purchase shall apply.

Welded pipes MDSs specifying acceptance classes give welding quality factors ranging from 0.8 to 1.0 according to ASME B31.3. The required class shall be specified on the piping class sheet and the purchase order shall specify acceptable class for each relevant item.

The element data sheets (EDSs) are included in Annex B. They define the requirements for special processes and parts used in connection with manufacturing and/or assembly of piping and valves. Processes and parts shall comply with the minimum requirement specified in the EDS and any standard referenced therein.

4.2 MDS and EDS numbering system

A new numbering convention is used for all MDSs and a table comparing the current MDS number with the MDS number in the previous revision of this specification is presented in Annex A.

Each MDS and EDS number consists of a two-letter prefix followed by a three-digit sequential number and a supplementary requirements suffix.

The first letter is fixed and consists of the letter "I" to indicate an IOGP MDS or EDS.

The second letter identifies the type of material or element with the following interpretation:

C – carbon steels

D – ferritic-austenitic stainless steels, type 22Cr duplex, type 25Cr duplex

H – hard facing, by welding, thermal spray, metal plating or use of sintered material

K – copper-nickel alloy 90-10 and other copper alloys including aluminium bronze

N – nickel alloys

O – overlay welding, corrosion – resistant

R – austenitic stainless steels, type 6Mo

S – austenitic stainless steels, excluding type 6Mo

T – titanium and titanium alloys

U – Precipitation-hardened stainless steels

X – high strength low alloyed steels.

The supplementary suffix “S” shall be used to designate a material delivered in accordance with the MDS plus the supplementary requirements for sour service, but excluding HIC testing.

The supplementary suffix “SH” shall be used to designate a material complying with the MDS including the supplementary requirements for sour service plus HIC testing and UT examination, where applicable to the material and product form.

Material data sheets designated with supplementary suffix “S” or “SH” also satisfy all the MDS requirements for general, non-sour service.

EXAMPLE 1 MDS IC003 designates carbon steel fittings for general, non-sour service, as opposed to IC003S which designates carbon steel fittings which also comply with the additional supplementary requirements for sour service, excluding HIC testing.

EXAMPLE 2 MDS IC003SH designates carbon steel fittings complying with the additional supplementary requirements for sour service plus HIC and UT testing, where applicable.

4.3 Implementation of statutory regulations

This specification is not intended to address any statutory regulations. The responsibility for complying with any such statutory regulations and the specification of any further additional requirements is the responsibility of the end (equipment) user.

4.4 Ferritic-austenitic stainless steels (MDS ID series)

The compositional and microstructural requirements including ferrite content and acceptance criteria for intermetallic phases and precipitates in parent material and welds are specified in accordance with ISO 17781. Compliance with ISO 17781 is considered to fulfil the microstructural requirements of ISO 15156-3 /NACE MR0175-3.

4.5 Mechanical testing

Tensile testing shall in general be carried out in accordance with the referenced standard specifications in the respective MDS. Where testing to ASTM A370 is specified, testing in accordance with ISO 6892-1 is considered equivalent and thereby also acceptable. The elongation shall be measured and reported in accordance with the selected tensile test standard ASTM A370 or ISO 6892-1. For specimens to ASTM A370, the gauge length shall be 50 mm as far as is practically possible.

Impact testing shall, in general, be carried out in accordance with the referenced standard specifications in the respective MDS. Where testing to ASTM A370 is specified, testing in accordance with ISO 148-1 using a striker radius of 8 mm is considered equivalent and thereby also acceptable.

The impact test temperature for carbon and duplex stainless steels is in general specified to be minus 46 °C. The use of a lower test temperature is acceptable, but the specified minimum absorbed energy shall apply unless otherwise agreed with the end (equipment) user.

Hardness testing shall be performed in strict compliance with the methods described in the MDS and EDS, as applicable. The use of alternative methods permitted by the product standard and use of conversion

tables or other correlations for individual materials shall require approval of the end (equipment) user. In case of dispute, the hardness scale stated in the MDS or EDS shall govern. For the purposes of this specification, ASTM E384 is equivalent to ISO 6507-1, ASTM E18 is equivalent to ISO 6508-1 and ASTM E10 is equivalent to ISO 6506-1. The use of portable hardness testing methods shall require approval by the end (equipment) user.

4.6 Machining of valve components from bar

When allowed by the product standard specifications, hollow cylindrically shaped parts, including valve bodies for weld-end and integral flanged valves, and pressure-controlling parts of valves, may be manufactured from cylindrically shaped bars, provided the requirements in the relevant MDS are met in full.

4.7 NDT of piping and valve components

4.7.1 General

Where MDSs specify NDT requirements, this is intended to represent the minimum level of NDT that shall be performed at the material manufacturing stage.

NDT of fabricated piping systems are not included in the MDSs and additional NDT may be required for valve components when a quality specification level (QSL) is specified by the purchaser in the valve data sheet or purchase order documentation. For details of any additional NDT requirements for finished valve components or piping assembly, reference shall be made to the applicable IOGP valve specification or piping fabrication specification.

Where MDSs do not specify additional NDT requirements, the relevant material standard shall apply with no additional requirements except as specified below in this section.

Where a frequency of inspection less than 100 % is specified, at least one item per lot shall be examined. If defects outside the acceptance criteria are detected, two or more items from the same lot shall be tested and if any of these two fails, all items in the lot shall be examined.

4.7.2 NDT Personnel

NDT personnel shall be qualified in accordance with ISO 9712 or ASNT SNT-TC-1A. Personnel performing NDT evaluation shall be certified according to Level 2. Certification shall be performed by an independent third-party certification body, or authorized qualifying body in accordance with ISO 9712 or the ASNT Central Certification Program (ACCP).

4.8 Pilot castings

4.8.1 General

The casting foundry/manufacturer shall produce a pilot casting (see definition in 3.1.15) prior to the production of castings, in accordance with MSS SP-147.

The pilot casting may be taken from the first production order of castings, subject to purchaser approval. Acceptance of a production casting as pilot casting shall require that NDT complies with the requirements for pilot casting and all testing specified in the MDS for production casting shall be met.

4.8.2 Material qualification ranges for pilot castings

A new pilot casting shall be produced when the casting material is outside the qualification ranges given in Table 1.

Table 1 – Pilot casting material qualification ranges.

| Pilot casting material type | Qualification range for pilot casting material |
|--------------------------------------|---|
| Carbon steel | All grades of carbon steel and low alloyed steel |
| Low-alloy steel | All grades of carbon steel and low alloyed steel |
| Austenitic stainless steel | All grades of austenitic stainless steel except 6Mo, Ni-alloys |
| 22Cr and 25Cr duplex stainless steel | All grades of 22Cr and 25Cr duplex stainless steel |
| 6Mo stainless steel | All grades of 6Mo and austenitic stainless steel, Ni-alloys |
| Nickel alloys | All grades of austenitic stainless steel including 6Mo, Ni-alloys |
| Titanium (un-alloyed) | All un-alloyed grades of titanium |
| Ni-Al bronze | All grades of Ni-Al bronze |

4.8.3 NDE of pilot castings

All pilot castings shall be evaluated without weld repairs.

All accessible internal and external surfaces of the pilot casting shall be inspected by VT, PT or MT. The extent of volumetric inspection shall be in accordance with the applicable casting MDS. The acceptance criteria shall be as stated in the applicable casting MDS, unless agreed otherwise with the end (equipment) user.

Dimensional inspection shall be in accordance with the casting design drawing.

A pilot casting that fails to comply with the requirements of the MDS shall be rejected. Corrective actions shall be implemented by the casting foundry/manufacturer and a new pilot casting shall be made to confirm effectiveness of the corrective actions.

Upon completion of all required examinations and tests, the documentation for the pilot casting shall be retained and be available for review at the casting foundry/manufacturer.

Annex A (normative) Material Data Sheets

A.1 List of material data sheets

The material data sheets are listed in Table 2 and compiled in this annex.

Table 2 – List of material data sheets per type of material

| Type of Material | Material Standard and Grade(s) | Product Form | MDS No. | MDS Rev. | Previous MDS No. ^a |
|---|----------------------------------|------------------|---------|----------|-------------------------------|
| Non-impact tested carbon steel | ASTM A106 Grade B | Seamless pipes | IC001 | 01 | IC01 |
| | API SPEC 5L Grade B PSL1, PSL2 | Seamless pipes | IC001 | 01 | |
| | ASTM A672 Grade C60, C65, C70 | Welded pipes | IC002 | 01 | |
| | API SPEC 5L Grade B PSL1, PSL2 | Welded pipes | IC002 | 01 | |
| | ASTM A234 Grade WPB, WPBW | Wrought fittings | IC003 | 01 | |
| | ASTM A105 | Forgings | IC004 | 01 | |
| | ASTM A516 Grade 60, 65, 70 | Plates | IC005 | 01 | |
| | ASTM A216 Grade WCB and WCC | Castings | IC006 | 01 | IC02 |
| | ASTM A696 Grade B or and C | Bars | IC007 | 01 | IC01 |
| Impact tested carbon steel | ASTM A333 Grade 6 | Seamless pipes | IC101 | 01 | IC11 |
| | ASTM A671 Grade CC60, CC65, CC70 | Welded pipes | IC102 | 01 | |
| | ASTM A420 Grade WPL 6 | Wrought fittings | IC103 | 01 | |
| | ASTM A350 Grade LF2 and LF6 | Forgings | IC104 | 01 | |
| | ASTM A516 Grade 60, 65, 70 | Plates | IC105 | 01 | |
| | ASTM A352 Grade LCC | Castings | IC106 | 01 | IC12 |
| | ASTM A696 Grade B or and C | Bars | IC107 | 01 | IC11 |
| Ferritic-austenitic stainless steel type 22Cr Duplex | ASTM A790 UNS S31803, UNS S32205 | Seamless pipes | ID141 | 01 | ID41 |
| | ASTM A928 UNS S31803, UNS S32205 | Welded pipes | ID142 | 01 | ID42 |
| | ASTM A815 UNS S31803, UNS S32205 | Wrought fittings | ID143 | 01 | ID43 |
| | ASTM A182 Grade F51, F60 | Forgings | ID144 | 01 | ID44 |

| Type of Material | Material Standard and Grade(s) | Product Form | MDS No. | MDS Rev. | Previous MDS No. ^a |
|---|--|--------------------------|---------|----------|-------------------------------|
| Ferritic-austenitic stainless steel type 22Cr Duplex | ASTM A240 UNS S31803, UNS S32205 | Plates | ID145 | 01 | ID45 |
| | ASTM A995 Grade 4A (UNS J92205) | Castings | ID146 | 01 | ID46 |
| | ASTM A276/A479 UNS S31803, UNS S32205 | Bars | ID147 | 01 | ID47 |
| | ASTM A789 UNS S31803, UNS S32205 | Tubes | ID148 | 01 | ID48 |
| | ASTM A988 UNS S31803, S32205 | HIP products | ID149 | 01 | ID43/ ID44 |
| Ferritic-austenitic stainless steel type 25Cr Duplex | ASTM A790 UNS S32550, S32750, S32760 | Seamless pipes | ID251 | 01 | ID51 |
| | ASTM A928 UNS S32550, S32750 and S32760 | Welded pipes | ID252 | 01 | ID52 |
| | ASTM A815 UNS S32550, S32750 and S32760 | Wrought fittings | ID253 | 01 | ID53 |
| | ASTM A182 Grade F53 (UNS S32750), Grade F55 (UNS S32760), Grade F61 (UNS S32550) | Forgings | ID254 | 01 | ID54 |
| | ASTM A240 UNS S32550, S32750 and S32760 | Plates | ID255 | 01 | ID55 |
| | ASTM A995 Grade 6A (UNS J93380), Grade 5A (UNS J93404) | Castings | ID256 | 01 | ID56 |
| | ASTM A276/A479 UNS S32550, S32750 and S32760 | Bars | ID257 | 01 | ID57 |
| | ASTM A789 UNS S32550, S32750, S32760 | Tubes | ID258 | 01 | ID58 |
| | ASTM A1082 (modified) UNS S32750, S32760 (strain hardened) | Bolting | ID259 | 01 | ID59 |
| | ASTM A1082 UNS S32750, S32760 (solution annealed) | Bolting | ID260 | 01 | ID60 |
| | ASTM A988 UNS S32750, S32750, S32505 | HIP products | ID269 | 01 | ID53/ ID54 |
| Copper-nickel 90-10 | ASTM B466 UNS C70600 | Seamless pipes and tubes | IK101 | 01 | IK01 |
| | ASTM B467 UNS C70600 | Welded pipes | IK102 | 01 | |
| | EEMUA 234 UNS C70600 | Wrought Fittings | IK103 | 01 | |
| | EEMUA 234 UNS C70600 | Flanges | IK104 | 01 | |

| Type of Material | Material Standard and Grade(s) | Product Form | MDS No. | MDS Rev. | Previous MDS No. ^a |
|--|--|--|---------------------|----------|-------------------------------|
| Copper-nickel 90-10 | ASTM B171 UNS C70600 | Plates and sheets | IK105 | 01 | IK01 |
| | ASTM B151 UNS C70600 | Bars and rods | IK107 | 01 | |
| Aluminium - bronze castings | ASTM B148 UNS C95800 | Castings | IK106 | 01 | IK02 |
| Nickel alloys | ASTM F467 UNS N06625 Grade 2 | Nuts | IN100S ^b | 01 | IN03 |
| | ASTM F468 UNS N06625 | Studs, bolts, screws | IN100S ^b | 01 | |
| | ASTM B705 UNS N06625 | Welded pipes | IN102S ^b | 01 | IN01 |
| | ASTM B366 UNS N06625 | Wrought fittings | IN103S ^b | 01 | |
| | ASTM B564 UNS N06625 | Forgings | IN104S ^b | 01 | |
| | ASTM B443 UNS N06625 | Plates | IN105S ^b | 01 | |
| | ASTM A494 Grade CW-6MC, CX 2MW | Castings | IN106S ^b | 01 | IN02 |
| | ASTM B446 UNS N06625 | Bars | IN107S ^b | 01 | IN01 |
| | ASTM B444 UNS N06625 | Seamless pipes and tubes | IN111S ^b | 01 | IN01 |
| | ASTM B834 UNS N06625 Grade 1 | HIP products | IN119S ^b | 01 | - |
| | ASTM A962, API STD 6ACRA Gr. 120K | Bolting | IN120S ^b | 01 | - |
| | Austenitic stainless steel type 6Mo | ASTM A312 UNS S31254, UNS N08367, N08926 | Seamless pipes | IR111 | 01 |
| ASTM A358 UNS S31254, UNS N08367, N08926 | | Welded pipes | IR112 | 01 | IR12 |
| ASTM A403 UNS S31254, N08367, N08926 | | Wrought fittings | IR113 | 01 | IR13 |
| ASTM A182 Grade F44 (UNS S31254), F62 (UNS N08367), UNS N08926 | | Forgings | IR114 | 01 | IR14 |
| ASTM A240 UNS S31254, N08367, N08926 | | Plates | IR115 | 01 | IR15 |
| ASTM A351 Grade CK-3MCuN, CN-3MN | | Castings | IR116 | 01 | IR16 |
| ASTM A276/A479 UNS S31254, N08367, N08926 | | Bars | IR117 | 01 | IR17 |
| ASTM A269 UNS S31254, N08367, N08926 | | Tubes | IR118 | 01 | IR18 |

| Type of Material | Material Standard and Grade(s) | Product Form | MDS No. | MDS Rev. | Previous MDS No. ^a |
|--|--------------------------------|------------------|---------|----------|-------------------------------|
| Austenitic stainless steel type 6Mo | ASTM A988 UNS S31254, N08367 | HIP products | IR119 | 01 | - |
| Austenitic stainless steel type 316 | ASTM A312 Grade TP316 | Seamless pipes | IS101 | 01 | IS01 |
| | ASTM A312 Grade TP316 | Welded pipes | IS102 | 01 | |
| | ASTM A358 Grade 316 | Welded pipes | IS102 | 01 | |
| | ASTM A403 Grade WP316 | Wrought fittings | IS103 | 01 | |
| | ASTM A182 Grade F316 | Forgings | IS104 | 01 | |
| | ASTM A240 Grade 316 | Plates | IS105 | 01 | |
| | ASTM A351 Grade CF3M, CF8M | Castings | IS106 | 01 | IS02 |
| | ASTM A276/A479 Grade 316 | Bars | IS107 | 01 | IS01 |
| | ASTM A269 Grade 316 | Tubes | IS108 | 01 | |
| Austenitic stainless steel type 304 | ASTM A312 Grade TP304 | Seamless pipes | IS221 | 01 | IS21 |
| | ASTM A312 Grade TP304 | Welded pipes | IS222 | 01 | |
| | ASTM A358 Grade 304 | Welded pipes | IS222 | 01 | |
| | ASTM A403 Grade WP304 | Wrought fittings | IS223 | 01 | |
| | ASTM A182 Grade F304 | Forgings | IS224 | 01 | |
| | ASTM A240 Grade 304 | Plates | IS225 | 01 | |
| | ASTM A351 Grade CF3, CF8 | Castings | IS226 | 01 | IS22 |
| | ASTM A276/A479 Grade 304 | Bars | IS227 | 01 | IS21 |
| | ASTM A269 Grade 304 | Tubes | IS228 | 01 | |
| Titanium Grade 2 | ASTM B861 Grade 2 | Seamless pipes | IT101 | 01 | IT01 |
| | ASTM B862 Grade 2 | Welded pipes | IT102 | 01 | |
| | ASTM B363 Grade WPT2/WPT2W | Wrought fittings | IT103 | 01 | |
| | ASTM B381 Grade F2 | Forgings | IT104 | 01 | |
| | ASTM B265 Grade 2 | Plates | IT105 | 01 | |
| | ASTM B367 Grade C2 | Castings | IT106 | 01 | IT02 |
| | ASTM B348 Grade 2 | Bars | IT107 | 01 | IT01 |
| | ASTM B338 Grade 2 | Tubes | IT108 | 01 | |

| Type of Material | Material Standard and Grade(s) | Product Form | MDS No. | MDS Rev. | Previous MDS No. ^a |
|--|----------------------------------|--|---------|----------|-------------------------------|
| Precipitation-hardened stainless steels | ASTM A453 Grade 660 (UNS S66286) | Bolting | IU100 | 01 | IN04 |
| High strength low alloy steel | ASTM A320 Grade L7, L7M, L43 | Studs, bolts, screws (HDG) | IX100 | 01 | IX07 |
| | ASTM A194 Grade 7, 7M, L43 | Nuts (HDG) | IX100 | 01 | IX07 |
| | ASTM A320 Grade L7, L7M, L43 | Studs, bolts, screws (Black or uncoated) | IX109 | 01 | IX09 |
| | ASTM A194 Grade 7, 7M | Nuts (Black or uncoated) | IX109 | 01 | IX09 |
| | ASTM A193 Grade B7, B7M | Studs, bolts, screws (Black or uncoated) | IX110 | 01 | IX10 |
| | ASTM A194 Grade 2H, 2HM | Nuts (Black or uncoated) | IX110 | 01 | IX10 |
| | ASTM A193 Grade B7, B7M | Studs, bolts, screws (HDG) | IX120 | 01 | IX08 |
| | ASTM A194 Grade 2H, 2HM | Nuts (HDG) | IX120 | 01 | IX08 |
| | ASTM A694 Grade F52, F60, F65 | Forgings | IX124 | 01 | - |
| | ASTM A29 Grade 4140 | Bars | IX127 | 01 | - |
| <p>NOTE The supplementary suffix "S" is added to the MDS designation to indicate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service, but excluding HIC testing and UT examination. The supplementary suffix "SH" is added to the MDS designation to indicate a material complying with the MDS including the additional supplementary requirements for sour service plus HIC testing and UT examination, where applicable to the product form.</p> <p>^a Previous MDS number in Rev. 1.1 of this specification.</p> <p>^b Material data sheets for Ni-alloy type 625 are designated with supplementary suffix "S" only.</p> | | | | | |

A.2 IOGP material data sheets

| Material Data Sheet | | MDS No. IC001 / IC001S ^a | | Rev. 01 |
|---|--|-------------------------------------|------------------|---------------------------|
| TYPE OF MATERIAL: Non-impact tested carbon steel | | | | |
| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
| Seamless pipes | ASTM A106 | B | - | ASTM A106 S6 |
| | API 5L | B | PSL1 or PSL2 | - |
| Page 1 of 1 | | | | |
| Scope | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| Metal Making | API 5L Gr.B PSL1 pipe steel shall be killed. | | | |
| Manufacturing | Cold-drawn pipes shall be heat treated after cold forming. | | | |
| Chemical Composition | For ASTM A106 supplementary requirement S6 applies with the following restrictions: $C \leq 0.23 \%$, $S \leq 0.020 \%$, $P \leq 0.025 \%$, $CE \leq 0.43 \%$ The following restrictions apply to API 5L pipes: $C \leq 0.23 \%$, $CE \leq 0.43 \%$ Microalloying elements (Nb, V, Ti, B) shall not be deliberately added. | | | |
| Repair of Defects | Weld repair is not permitted. | | | |
| Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^a | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of ISO 15156 /NACE MR0175 or ISO 17945 /NACE MR0103, and the following additional requirements to the MDS: <u>Chemical composition</u> $S \leq 0.010 \%$ <u>Hardness testing</u> Production hardness testing shall be performed in accordance with the requirements in ASTM A370/A1058 on one length of pipe per lot. The maximum hardness shall be 22HRC from three readings taken in close proximity. The material shall be traceable in accordance with ISO 15156-2 /NACE MR0175-2 section 9 and this MDS. | | | |
| Marking | The pipes shall be marked to ensure full traceability to melt and heat treatment lot. | | | |
| Certification | The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser. The inspection documents shall be issued in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification. The inspection documents shall include the following information: - Heat treatment condition. For tempered condition, tempering temperature shall be stated. | | | |
| ^a The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service. | | | | |

| Material Data Sheet | | | | |
|--|---|-------|---------------------------------------|---------------------------|
| MDS No. IC002 / IC002S ^a / IC002SH ^b | | | | Rev. 01 |
| TYPE OF MATERIAL: Non-impact tested carbon steel | | | | |
| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
| Welded pipes | ASTM A672 | C60 | Cl. 12 or Cl. 22 or Cl.32 or Cl.42 | - |
| | ASTM A672 | C65 | Cl. 12 or Cl. 22 or Cl.32 or Cl.42 | - |
| | ASTM A672 | C70 | Cl. 12 or Cl. 22 or Cl.32 or Cl.42 | - |
| | API 5L | B | PSL1 or PSL2 | - |
| Page 1 of 2 | | | | |
| Scope | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| Metal Making | API 5L Gr.B PSL1 pipe steel shall be killed and made according to fine grain practice. | | | |
| Manufacturing | <ul style="list-style-type: none"> - The longitudinal weld shall be straight and made using the SAW process. - The weld metal shall be mild steel analysis A-No.1 per ASME BPVC Sec. IX, Table QW-442. | | | |
| Chemical Composition | <p>C ≤ 0.23 %, S ≤ 0.020 %, P ≤ 0.025 %, CE ≤ 0.43 %</p> <p>Microalloying elements (Nb, V, Ti, B) shall not be deliberately added.</p> | | | |
| Heat Treatment | For products delivered in the tempered condition, the minimum tempering temperature shall be 620 °C (1 148 °F). | | | |
| Non-Destructive Testing | Welded pipe to API 5L: 100 % RT of weld seam. | | | |
| Repair of Defects | <p>Weld repair of the base material is not permitted.</p> <p>Repairs to weld metal are acceptable in accordance with the standard specification and shall meet the chemistry requirements of the original manufacturing weld.</p> | | | |
| Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^{a, b} | <p>When sour service requirements are specified by the purchaser, the material shall conform to the requirements of ISO 15156 /NACE MR0175 or ISO 17945 /NACE MR0103, and the following additional requirements to the MDS:</p> <p><u>Chemical composition</u></p> <p>S ≤ 0.003 %</p> <p>Ni < 1.0 % for the weld metal</p> <p><u>Hardness testing</u></p> <ul style="list-style-type: none"> - Welding procedure qualification testing for manufacturing and any repair welding shall meet the requirements of NACE MR0175-2 /ISO 15156-2 section 7.3.3, using Vickers method, with a maximum hardness of 250HV. - Production testing shall be performed on one length of pipe per lot as follows: Vickers hardness traverse shall be made across the base material, HAZ and weld metal at both ends of the pipe to include the centre of the pipe wall and 1.0 mm - 2.0 mm below the internal and external surfaces, with a maximum hardness of 250HV. <p><u>HIC testing and UT examination</u></p> <p>When suffix SU applies, one finished pipe per ASTM A672 S14 (lot) shall be tested as follows:</p> <ul style="list-style-type: none"> - HIC testing: <ul style="list-style-type: none"> • HIC testing in accordance with NACE TM0284, using Test Solution A. • Acceptance criteria per specimen shall be CLR ≤ 15%, CTR ≤ 5 %, CSR ≤ 2 %. • Maximum individual crack length shall be reported for each section. - UT examination: <ul style="list-style-type: none"> • ASTM A672, S11 shall apply. <p>The material shall be traceable in accordance with ISO 15156-2 /NACE MR0175-2 section 9 and this MDS.</p> | | | |

Material Data Sheet **MDS No. IC002 / IC002S^a / IC002SH^b** **Rev. 01**

TYPE OF MATERIAL: Non-impact tested carbon steel

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|---------------------|-----------------|--------------|---------------------------------------|----------------------------------|
| Welded pipes | ASTM A672 | C60 | Cl. 12 or Cl. 22 or Cl.32 or Cl.42 | - |
| | ASTM A672 | C65 | Cl. 12 or Cl. 22 or Cl.32 or Cl.42 | - |
| | ASTM A672 | C70 | Cl. 12 or Cl. 22 or Cl.32 or Cl.42 | - |
| | API 5L | B | PSL1 or PSL2 | - |

Page 2 of 2

| | |
|----------------------|---|
| Marking | The pipes shall be marked to ensure full traceability to melt and heat treatment lot. |
| Certification | The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser. |
| | <p>The inspection documents shall be issued in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification.</p> <p>The inspection documents shall include the following information:</p> <ul style="list-style-type: none"> - Heat treatment condition. For tempered condition, tempering temperature shall be stated. |

^a The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service, but excluding HIC testing and UT examination.

^b The supplementary suffix "SH" shall be used to designate a material delivered in accordance with the MDS including the additional supplementary requirements for sour service plus HIC testing and UT examination.

| Material Data Sheet | | MDS No. IC003 / IC003S ^a / IC003SH ^b | | Rev. 01 |
|--|--|--|------------------|---------------------------|
| TYPE OF MATERIAL: Non-impact tested carbon steel | | | | |
| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
| Wrought fittings | ASTM A234 | WPB | - | ASTM A234 S3 |
| | ASTM A234 | WPBW | - | ASTM A234 S3 |
| Page 1 of 2 | | | | |
| Scope | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| Chemical Composition | Supplementary requirement ASTM A234 S3 applies with the following restrictions: $C \leq 0.23 \%$, $S \leq 0.020 \%$, $P \leq 0.025 \%$, $CE \leq 0.43 \%$ Microalloying elements (Nb, V, Ti, B) shall not be deliberately added. | | | |
| Heat Treatment | Normalized or normalized and tempered or quenched and tempered. For products delivered in the tempered condition, the minimum tempering temperature shall be 620 °C (1 148 °F). All hot formed or forged fittings, including those manufactured by locally heating a portion of the fitting stock, shall be heat treated after manufacture. | | | |
| Tensile Testing | Tensile testing shall be carried out on specimens cut from a fitting where dimensions permit. When removal of specimens is not possible due to the size of the fitting, a prolongation or a length of starting material that has been heat treated in the same heat treatment load as the fittings it represents shall be used. | | | |
| Non-Destructive Testing | UT is not acceptable in-lieu of RT. | | | |
| Repair of Defects | Weld repair of the base material is not permitted. Repairs to weld metal are acceptable in accordance with the standard specification and shall meet the chemistry requirements of the original manufacturing weld. | | | |
| Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^{a, b} | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of ISO 15156 /NACE MR0175 or ISO 17945 /NACE MR0103, and the following additional requirements to the MDS: <u>Chemical composition</u> – $S \leq 0.010 \%$ for WPB and WPBW fittings made from products other than flat-rolled or forged – $S \leq 0.003 \%$ for WPBW fitting made from flat-rolled products – $S \leq 0.020 \%$ for WPB fitting made from forging <u>Hardness testing</u> WPB fittings production hardness testing shall be performed in accordance with the requirements in ASTM A234. Hardness testing for WPBW fittings: – Welding procedure qualification testing for manufacturing and any repair welding shall meet the requirements of NACE MR0175-2 /ISO 15156-2 section 7.3.3, using Vickers method, with a maximum hardness of 250HV. – Production testing shall be performed in accordance with the requirements in ASTM A234 and shall include parent material, weld and HAZ. <u>HIC testing and UT examination</u> When suffix SH applies, one finished WPBW fitting made from flat-rolled products per lot shall be tested as follows: – HIC testing: • HIC testing in accordance with NACE TM0284, using Test Solution A. • Acceptance criteria per specimen shall be $CLR \leq 15 \%$, $CTR \leq 5 \%$, $CSR \leq 2 \%$. • Maximum individual crack length shall be reported for each section. – UT testing of flat-rolled product before manufacture: • ASTM A578, S1, S2.1 shall apply. | | | |
| The material shall be traceable in accordance with ISO 15156-2 /NACE MR0175-2 section 9 and this MDS. | | | | |

| Material Data Sheet | | | | | MDS No. IC003 / IC003S ^a / IC003SH ^b | | Rev. 01 | |
|--|---|-------|------------------|---------------------------|--|--|---------|--|
| TYPE OF MATERIAL: Non-impact tested carbon steel | | | | | | | | |
| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT | | | | |
| Wrought fittings | ASTM A234 | WPB | - | ASTM A234 S3 | | | | |
| | ASTM A234 | WPBW | - | ASTM A234 S3 | | | | |
| Page 2 of 2 | | | | | | | | |
| Marking | The fittings shall be marked to ensure full traceability to melt and heat treatment lot. | | | | | | | |
| Certification | The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser. | | | | | | | |
| | The inspection documents shall be issued in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification. | | | | | | | |
| | The inspection documents shall include the following information: – Heat treatment condition. For tempered condition, tempering temperature shall be stated. | | | | | | | |
| ^a The supplementary suffix “S” shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service, but excluding HIC testing and UT examination. ^b The supplementary suffix “SH” shall be used to designate a material delivered in accordance with the MDS including the additional supplementary requirements for sour service plus HIC testing and UT examination. | | | | | | | | |

Material Data Sheet **MDS No. IC004 / IC004S^a** **Rev. 01**

TYPE OF MATERIAL: Non-impact tested carbon steel

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|--------------|-----------|-------|------------------|---------------------------|
| Forgings | ASTM A105 | - | - | ASTM A105 S2, S4 |

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|---|--|
| Scope | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. |
| Chemical Composition | Supplementary requirement S4 applies with the following restrictions: C ≤ 0.23 %, S ≤ 0.020 %, P ≤ 0.025 %, CE ≤ 0.43 % Microalloying elements (Nb, V, Ti, B) shall not be deliberately added. |
| Heat Treatment | Normalized or normalized and tempered or quenched and tempered. For products delivered in the tempered condition, the minimum tempering temperature shall be 620 °C (1 148 °F). |
| Non-Destructive Testing | <u>Visual inspection</u> VT shall be carried out on each forging or bar in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be cleaned prior to the testing. <u>Valve forgings NDT</u> Inspection shall be according to the applicable valve specification. If a QSL is not specified by the purchaser, the NDT requirements in this MDS shall apply. |
| Repair of Defects | Weld repair is not permitted. |
| Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^a | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of ISO 15156 /NACE MR0175 or ISO 17945 /NACE MR0103, and the following additional requirements to the MDS: <u>Hardness testing</u> Production hardness testing shall be performed in accordance with the requirements in ASTM A105. The material shall be traceable in accordance with ISO 15156-2 /NACE MR0175-2 section 9 and this MDS. |
| Marking | The forgings shall be marked to ensure full traceability to melt and heat treatment lot. |
| Certification | The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser. The inspection documents shall be issued in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification. The inspection documents shall include the following information: – Heat treatment condition. For tempered condition, tempering temperature shall be stated. |

^a The supplementary suffix “S” shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| Material Data Sheet | | | | |
|--|--|-------|------------------|---------------------------|
| MDS No. IC005 / IC005S ^a / IC005SH ^b | | | Rev. 01 | |
| TYPE OF MATERIAL: Non-impact tested carbon steel | | | | |
| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
| Plates | ASTM A516 | 60 | - | - |
| | ASTM A516 | 65 | - | - |
| | ASTM A516 | 70 | - | - |
| Page 1 of 2 | | | | |
| Scope | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| Chemical Composition | <p>C ≤ 0.23 %, S ≤ 0.020 %, P ≤ 0.025 %, CE ≤ 0.43 % For Grade 60 plate 12.5 mm thick and thinner, C ≤ 0.21 %</p> <p>Microalloying elements (Nb, V, Ti, B) shall not be deliberately added.</p> | | | |
| Non-Destructive Testing | <p><u>Visual inspection</u> VT shall be carried out on each plate in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be cleaned prior to the testing.</p> <p><u>Valve plates NDT</u> Inspection of plates for valve parts shall be according to the applicable valve specification. If a QSL is not specified by the purchaser, the requirements in this MDS shall apply.</p> | | | |
| Repair of Defects | Weld repair is not permitted. | | | |
| Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^{a, b} | <p>When sour service requirements are specified by the purchaser, the material shall conform to the requirements of ISO 15156 /NACE MR0175 or ISO 17945 /NACE MR0103, and the following additional requirements to the MDS:</p> <p><u>Chemical composition</u> S ≤ 0.003 %</p> <p><u>Hardness testing</u> Production testing shall be performed in accordance with the requirements in ASTM A370/A1058 on one plate per lot. The maximum hardness shall be 22HRC from three readings taken in close proximity at each location.</p> <p><u>HIC testing and UT examination</u> When suffix SH applies, one plate per lot shall be tested as follows:</p> <ul style="list-style-type: none"> - HIC testing: <ul style="list-style-type: none"> • HIC testing in accordance with NACE TM0284, using Test Solution A. • Acceptance criteria per specimen shall be CLR ≤ 15 %, CTR ≤ 5 %, CSR ≤ 2 %. • Maximum individual crack length shall be reported for each section. - UT examination: <ul style="list-style-type: none"> • ASTM A578, S1, S2.1 shall apply. <p>The material shall be traceable in accordance with ISO 15156-2 /NACE MR0175-2 section 9 and this MDS.</p> | | | |
| Marking | The plates shall be marked to ensure full traceability to melt and heat treatment lot. | | | |

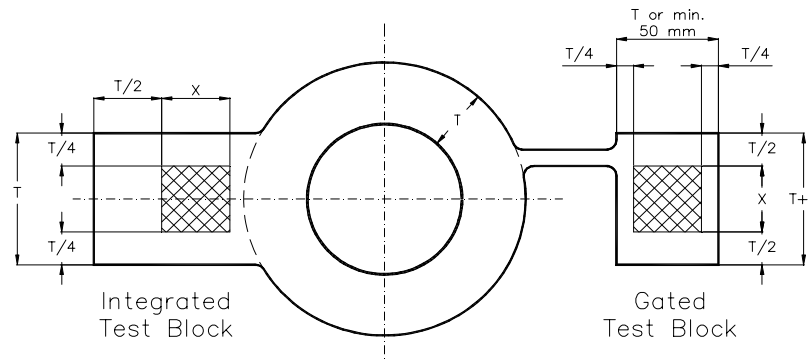
| Material Data Sheet | | | | |
|---|--|-------|------------------|---------------------------|
| MDS No. IC005 / IC005S ^a / IC005SH ^b | | | | Rev. 01 |
| TYPE OF MATERIAL: Non-impact tested carbon steel | | | | |
| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
| Plates | ASTM A516 | 60 | - | - |
| | ASTM A516 | 65 | - | - |
| | ASTM A516 | 70 | - | - |
| Page 2 of 2 | | | | |
| Certification | <p>The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser.</p> <p>The inspection documents shall be issued in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification.</p> <p>The inspection documents shall include the following information:</p> <ul style="list-style-type: none"> - Heat treatment condition. For tempered condition, tempering temperature shall be stated. | | | |
| <p>^a The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service, but excluding HIC testing and UT examination.</p> <p>^b The supplementary suffix "SH" shall be used to designate a material delivered in accordance with the MDS including the additional supplementary requirements for sour service plus HIC testing and UT examination.</p> | | | | |

Material Data Sheet **MDS No. IC006 / IC006S^a** **Rev. 01**

TYPE OF MATERIAL: Non-impact tested carbon steel

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|--------------|-----------|-------|------------------|--|
| Castings | ASTM A216 | WCB | - | ASTM A216 S4, S5, S11, S52 ASTM A703 S12, S14, S20 ASTM A985 S12, S14, S20 |
| | ASTM A216 | WCC | - | ASTM A216 S4, S5, S11, S52 ASTM A703 S12, S14, S20 ASTM A985 S12, S14, S20 |

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|-----------------------------|--|
| Scope | <p>This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification.</p> <p>For steel castings produced by the investment casting process, the requirements of ASTM A985 and this MDS shall apply.</p> |
| Chemical Composition | <p>Supplementary requirements ASTM A216 S11 and S52 apply with the following restrictions: C ≤ 0.23 %, S ≤ 0.020 %, P ≤ 0.025 %, CE ≤ 0.43 %</p> <p>Microalloying elements (Nb, V, Ti, B) shall not be deliberately added.</p> |
| Heat Treatment | <p>For products delivered in the tempered condition, the minimum tempering temperature shall be 620 °C (1 148 °F).</p> |
| Extent of Testing | <p>ASTM A703 S14 or ASTM A985 S14 shall apply.</p> |
| Test Sampling | <p>For castings with weight 250 kg (551 lb) or more the test blocks shall be integrally cast or gated onto the casting and shall accompany the castings through all heat treatment operations including any post weld stress relieving. Thickness of the test block shall be equal to the thickest part of the casting represented up to a maximum thickness of 100 mm (4 in). For flanged components, the largest flange thickness is the ruling section. Dimensions of test blocks and location of test specimens within the test blocks are shown in figure below for integral and gated test block. The test specimens shall be taken within the cross hatched area. Distance from end of test specimen to end of test block shall minimum be T/4.</p>  <p>For investment casting, test sampling shall be according to ASTM A985. Test blocks shall accompany the castings through all heat treatment operations including any post weld stress relieving.</p> |

Material Data Sheet **MDS No. IC006 / IC006S^a** **Rev. 01**

TYPE OF MATERIAL: Non-impact tested carbon steel

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|--------------|-----------|-------|------------------|--|
| Castings | ASTM A216 | WCB | - | ASTM A216 S4, S5, S11, S52 ASTM A703 S12, S14, S20 ASTM A985 S12, S14, S20 |
| | ASTM A216 | WCC | - | ASTM A216 S4, S5, S11, S52 ASTM A703 S12, S14, S20 ASTM A985 S12, S14, S20 |

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Non-Destructive Testing

Visual inspection

| NDE requirement | Pilot casting (section 4.8) | Production casting |
|---------------------|---|-------------------------|
| Frequency | Each pilot casting | Each production casting |
| Method | ANSI/MSS SP-55 | |
| Extent | 100 % of all accessible surfaces including welding ends | |
| Acceptance criteria | ANSI/MSS SP-55 | |

NOTE The testing shall be carried out after machining, if applicable. Non-machined surfaces shall be cleaned prior to the testing.

Magnetic particle testing

ASTM A216 Supplementary requirement S4 shall apply as amended by this MDS:

| NDE Requirement | Pilot casting (section 4.8) | Production casting ^a |
|------------------------|---|---|
| Frequency ^b | 100 % | 100 % |
| Method | ASME BPVC Sec. V, Article 7 | ASME BPVC Sec. V, Article 7 |
| Extent ^c | 100 % | 100 % |
| Acceptance criteria | ASME BPVC Sec. VIII, Div. 1, Appendix 7 | ASME BPVC Sec. VIII, Div. 1, Appendix 7 |

NOTE The testing shall be carried out after machining, if applicable. Non-machined surfaces shall be cleaned prior to the testing.

^a Production valve casting, MT shall be according to the applicable valve specification. If a QSL is not specified by the purchaser, the requirements in this table shall apply.

^b Frequency of inspection 100 % means that each item shall be examined.

^c All accessible internal and external surfaces shall be examined.

Material Data Sheet**MDS No. IC006 / IC006S^a****Rev. 01**

TYPE OF MATERIAL: Non-impact tested carbon steel

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|--------------|-----------|-------|------------------|--|
| Castings | ASTM A216 | WCB | - | ASTM A216 S4, S5, S11, S52 ASTM A703 S12, S14, S20 ASTM A985 S12, S14, S20 |
| | ASTM A216 | WCC | - | ASTM A216 S4, S5, S11, S52 ASTM A703 S12, S14, S20 ASTM A985 S12, S14, S20 |

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| Non-Destructive Testing | <p><u>Radiographic testing</u> ASTM A216 supplementary requirement S5 shall apply as amended by this MDS:</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th rowspan="2" style="width: 15%;">NDE requirement</th> <th rowspan="2" style="width: 15%;">Pilot casting (section 4.8)</th> <th colspan="4">Production casting</th> </tr> <tr> <th colspan="3">Valve castings^a</th> <th>Other pressure containing castings^b</th> </tr> </thead> <tbody> <tr> <td rowspan="7">Frequency^c</td> <td rowspan="7">100 %</td> <th>NPS</th> <th>DN</th> <th colspan="2">Pressure class</th> <td rowspan="7">100 %</td> </tr> <tr> <td></td> <td></td> <th>≤ 300</th> <th>600</th> <th>900</th> <th>≥ 1500</th> </tr> <tr> <td>< 2</td> <td>< 50</td> <td>N/R</td> <td>N/R</td> <td>N/R</td> <td>N/R</td> </tr> <tr> <td>≥ 2</td> <td>≥ 50</td> <td>N/R</td> <td>5 %</td> <td>5 %</td> <td>5 %</td> </tr> <tr> <td>≥ 6</td> <td>≥ 150</td> <td>N/R</td> <td>5 %</td> <td>5 %</td> <td>100 %</td> </tr> <tr> <td>≥ 10</td> <td>≥ 250</td> <td>5 %</td> <td>5 %</td> <td>5 %</td> <td>100 %</td> </tr> <tr> <td>≥ 16</td> <td>≥ 400</td> <td>5 %</td> <td>5 %</td> <td>100 %</td> <td>100 %</td> </tr> <tr> <td>≥ 20</td> <td>≥ 500</td> <td>5 %</td> <td>100 %</td> <td>100 %</td> <td>100 %</td> </tr> <tr> <td>Method</td> <td colspan="5" style="text-align: center;">ASME BPVC Sec. V, Article 2</td> </tr> <tr> <td>Extent</td> <td colspan="3">Areas defined by ASME B16.34 for special class valves, at abrupt changes in sections and at the junctions of risers, gates or feeders to the casting</td> <td colspan="2" style="text-align: center;">100 %^d</td> </tr> <tr> <td>Acceptance criteria</td> <td colspan="5" style="text-align: center;">ASME BPVC Sec. VIII, Div. 1, Appendix 7</td> </tr> </tbody> </table> <p>NOTE N/R means not required, unless specified otherwise by the purchaser.</p> <p>^a Production valve casting, RT shall be according to the applicable valve specification. If a QSL is not specified by the purchaser, the requirements in this table shall apply.</p> <p>^b Production casting other than valve casting.</p> <p>^c Frequency of inspection 100 % means that each item shall be examined. When random examination (5 %) is specified, a minimum of one item per lot of each pattern in any purchase order shall be examined.</p> <p>^d Production casting other than valve casting, inspection shall include other critical areas as defined in the purchase order and/or applicable product specification or standard. Sketches of the areas to be tested shall be established and agreed with the purchaser.</p> | | | | | NDE requirement | Pilot casting (section 4.8) | Production casting | | | | Valve castings ^a | | | Other pressure containing castings ^b | Frequency ^c | 100 % | NPS | DN | Pressure class | | 100 % | | | ≤ 300 | 600 | 900 | ≥ 1500 | < 2 | < 50 | N/R | N/R | N/R | N/R | ≥ 2 | ≥ 50 | N/R | 5 % | 5 % | 5 % | ≥ 6 | ≥ 150 | N/R | 5 % | 5 % | 100 % | ≥ 10 | ≥ 250 | 5 % | 5 % | 5 % | 100 % | ≥ 16 | ≥ 400 | 5 % | 5 % | 100 % | 100 % | ≥ 20 | ≥ 500 | 5 % | 100 % | 100 % | 100 % | Method | ASME BPVC Sec. V, Article 2 | | | | | Extent | Areas defined by ASME B16.34 for special class valves, at abrupt changes in sections and at the junctions of risers, gates or feeders to the casting | | | 100 % ^d | | Acceptance criteria | ASME BPVC Sec. VIII, Div. 1, Appendix 7 | | | | |
|--------------------------------|---|-----------------------------|-------|--------------------|---|-----------------|-----------------------------|--------------------|--|--|--|-----------------------------|--|--|---|------------------------|-------|-----|----|----------------|--|-------|--|--|-------|-----|-----|--------|-----|------|-----|-----|-----|-----|-----|------|-----|-----|-----|-----|-----|-------|-----|-----|-----|-------|------|-------|-----|-----|-----|-------|------|-------|-----|-----|-------|-------|------|-------|-----|-------|-------|-------|--------|-----------------------------|--|--|--|--|--------|--|--|--|--------------------|--|---------------------|---|--|--|--|--|
| NDE requirement | Pilot casting (section 4.8) | Production casting | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | Valve castings ^a | | | Other pressure containing castings ^b | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Frequency ^c | 100 % | NPS | DN | Pressure class | | 100 % | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | ≤ 300 | 600 | | 900 | ≥ 1500 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | < 2 | < 50 | N/R | N/R | | N/R | N/R | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | ≥ 2 | ≥ 50 | N/R | 5 % | | 5 % | 5 % | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | ≥ 6 | ≥ 150 | N/R | 5 % | | 5 % | 100 % | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | ≥ 10 | ≥ 250 | 5 % | 5 % | | 5 % | 100 % | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | ≥ 16 | ≥ 400 | 5 % | 5 % | | 100 % | 100 % | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ≥ 20 | ≥ 500 | 5 % | 100 % | 100 % | 100 % | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Method | ASME BPVC Sec. V, Article 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Extent | Areas defined by ASME B16.34 for special class valves, at abrupt changes in sections and at the junctions of risers, gates or feeders to the casting | | | 100 % ^d | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Acceptance criteria | ASME BPVC Sec. VIII, Div. 1, Appendix 7 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

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| Repair of Defects | <p>ASTM A703 or ASTM A985, as applicable, supplementary requirement S20 shall apply with the following additional requirements:</p> <ul style="list-style-type: none"> - Repairs as described in ASTM A216 section 10.2 and 10.3 shall be considered major repairs and shall be documented in accordance with ASTM A703 or ASTM A985 S20.2. - The repair welding procedure shall be qualified in accordance with ASTM A488 or ISO 11970 and this data sheet using a cast plate. - Weld repairs are not acceptable for castings that leak during pressure testing. - Examination of major repair welds on pressure containing parts shall also include RT. |
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Material Data Sheet **MDS No. IC006 / IC006S^a** **Rev. 01**

TYPE OF MATERIAL: Non-impact tested carbon steel

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|---------------------|-----------------|--------------|-------------------------|--|
| Castings | ASTM A216 | WCB | - | ASTM A216 S4, S5, S11, S52 ASTM A703 S12, S14, S20 ASTM A985 S12, S14, S20 |
| | ASTM A216 | WCC | - | ASTM A216 S4, S5, S11, S52 ASTM A703 S12, S14, S20 ASTM A985 S12, S14, S20 |

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| Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^a | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of ISO 15156 /NACE MR0175 or ISO 17945 /NACE MR0103, and the following additional requirements to the MDS: |
| | <p><u>Hardness testing</u></p> <ul style="list-style-type: none"> - Production testing shall be performed in accordance with the requirements in ASTM A370/A1058 on the pilot casting and one casting per lot thereafter. The maximum hardness shall be 22HRC from three readings taken in close proximity. - Welding procedure qualification testing for all repair welding shall meet the requirements of ISO 15156-2 /NACE MR0175-2 section 7.3.3, using Vickers method, with a maximum hardness of 250HV. |
| | The material shall be traceable in accordance with ISO 15156-2 /NACE MR0175-2 section 9 and this MDS. |
| Marking | The castings shall be marked to ensure full traceability to melt and heat treatment lot. |
| Certification | <p>The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser.</p> <p>The inspection documents shall be issued in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification.</p> <p>The inspection documents shall include the following information:</p> <ul style="list-style-type: none"> - Heat treatment condition. For tempered condition, tempering temperature shall be stated. |

^a The supplementary suffix “S” shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

Material Data Sheet **MDS No. IC007 / IC007S^a** **Rev. 01**

TYPE OF MATERIAL: Non-impact tested carbon steel

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|--------------|-----------|-------|------------------|---------------------------|
| Bars | ASTM A696 | B | - | |
| | ASTM A696 | C | - | |
| | ASTM A105 | - | - | |

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| Scope | <p>This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification.</p> <p>This MDS includes additional requirements for valve parts DN 100 (NPS 4) and under manufactured from bars, when permitted by the valve specification.</p> |
| Manufacturing | <p>Bars shall be manufactured to the following requirements:</p> <ul style="list-style-type: none"> - bar forgings as defined in ASTM A788 and certified to ASTM A105; or - hot rolled bars manufactured to ASTM A696 Grade B or C to a maximum outside diameter of 250 mm (10 in). <p>NOTE Cold finishing shall be restricted to turning, grinding or polishing (singly or in combination); cold drawing or cold forming is not permitted.</p> |
| Chemical Composition | <p>C ≤ 0.23 %, S ≤ 0.020 %, P ≤ 0.025 %, CE ≤ 0.43 %</p> <p>Microalloying elements (Nb, V, Ti, B) shall not be deliberately added.</p> |
| Heat Treatment | <p>Normalized or normalized and tempered or quenched and tempered. For products delivered in the tempered condition, the minimum tempering temperature shall be 620 °C (1 148 °F).</p> |
| Test Sampling | <p><u>Valve parts manufactured from bar</u></p> <p>Sampling of test specimens for bars intended for machining of valve parts shall comply with the following additional requirements:</p> <ul style="list-style-type: none"> - The mid-length of the axial tensile test specimen shall be located at a distance equal to the bar outside diameter or minimum of 100 mm (4 in), whichever is the greater, from the end of the bar, and the centreline of the specimen shall be located at a minimum distance of OD/4 from the surface. - The centreline of the tangential tensile test specimen shall be located at a minimum distance of OD/4 from the surface and the mid-point of the specimens at a minimum of 100 mm (4 in) from the end of the bar. - For bar with outside diameter < 100 mm (4 in): tensile test in accordance with the standard. - For bar with outside diameter ≥ 100 mm (4 in): in addition to the standard requirement, one tensile test specimen shall be taken in tangential direction of the bar. The specified minimum tensile strength properties of the referenced standard shall be met in both directions. |
| Non-Destructive Testing | <p><u>Visual Inspection</u></p> <p>VT shall be carried out on each bar in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be cleaned prior to the testing.</p> <p><u>NDT of valve parts manufactured from bar</u></p> <p>Inspection shall be according to the applicable valve specification.</p> <p>If a QSL is not specified by the purchaser, the requirements in this MDS shall apply.</p> |
| Repair of Defects | <p>Weld repair is not permitted.</p> |
| Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^a | <p>When sour service requirements are specified by the purchaser, the material shall conform to the requirements of ISO 15156 /NACE MR0175 or ISO 17945 /NACE MR0103, and the following additional requirements to the MDS:</p> <p><u>Chemical composition</u></p> <p>S ≤ 0.020 %, Ni < 1.0 %</p> <p><u>Hardness testing</u></p> <p>Production testing shall be performed in accordance with the requirements in ASTM A370/A1058 on the end surface of one bar per lot. The maximum hardness shall be 22HRC from three readings taken in close proximity.</p> |

Material Data Sheet **MDS No. IC007 / IC007S^a** **Rev. 01**

TYPE OF MATERIAL: Non-impact tested carbon steel

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|---------------------|-----------------|--------------|-------------------------|----------------------------------|
| Bars | ASTM A696 | B | - | |
| | ASTM A696 | C | - | |
| | ASTM A105 | - | - | |

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| Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^a | The material shall be traceable in accordance with ISO 15156-2 /NACE MR0175-2 section 9 and this MDS. |
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| Marking | The bars shall be marked to ensure full traceability to melt and heat treatment lot. |
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| Certification | <p>The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser.</p> <p>The inspection documents shall be issued in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification.</p> <p>The inspection documents shall include the following information:</p> <ul style="list-style-type: none"> - Heat treatment condition. For tempered condition, tempering temperature shall be stated. |
|----------------------|--|

^a The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| Material Data Sheet | | MDS No. IC101 / IC101S ^a | | | Rev. 01 |
|---|--|-------------------------------------|------------------|---------------------------|---------|
| TYPE OF MATERIAL: <i>Impact tested carbon steel</i> | | | | | |
| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT | |
| Seamless pipes | ASTM A333 | 6 | - | - | |
| Page 1 of 1 | | | | | |
| Scope | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | | |
| Chemical Composition | C ≤ 0.23 %, S ≤ 0.020 %, P ≤ 0.025 %, CE ≤ 0.43 % Microalloying elements (Nb, V, Ti, B) shall not be deliberately added. | | | | |
| Heat Treatment | During the heat treatment process, pipes shall be placed in such a way as to ensure free circulation around each pipe including any quenching operation. For products delivered in the tempered condition, the minimum tempering temperature shall be 620 °C (1 148 °F). | | | | |
| Impact Testing/ Toughness testing | Impact testing is required for thickness ≥ 6 mm (0.236 in); for pipes with a weld end, the weld end thickness shall govern. The test temperature shall be minus 46 °C (-50 °F). The minimum absorbed energy for full size specimens shall be 27 J (20 ft lbf) average and 20 J (15 ft lbf) single. | | | | |
| Repair of Defects | Weld repair is not permitted. | | | | |
| Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^a | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of ISO 15156 /NACE MR0175 or ISO 17945 /NACE MR0103, and the following additional requirements to the MDS: <u>Chemical composition</u> S ≤ 0.010 % <u>Hardness testing</u> Production hardness testing shall be performed in accordance with the requirements in ASTM A370/A1058 on one length of pipe per lot. The maximum hardness shall be 22HRC from three readings taken in close proximity. The material shall be traceable in accordance with ISO 15156-2 /NACE MR0175-2 section 9 and this MDS. | | | | |
| Marking | The pipes shall be marked to ensure full traceability to melt and heat treatment lot. | | | | |
| Certification | The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser. The inspection documents shall be issued in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification. The inspection documents shall include the following information: – Heat treatment condition. For tempered condition, tempering temperature shall be stated. | | | | |
| ^a The supplementary suffix “S” shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service. | | | | | |

| Material Data Sheet | | | | | MDS No. IC102 / IC102S ^a / IC102SH ^b | | Rev. 01 |
|--|--|--------------|------------------------------------|----------------------------------|--|--|---------|
| TYPE OF MATERIAL: Impact tested carbon steel | | | | | | | |
| <i>PRODUCT FORM</i> | <i>STANDARD</i> | <i>GRADE</i> | <i>ACCEPTANCE CLASS</i> | <i>SUPPLEMENTARY REQUIREMENT</i> | | | |
| Welded pipes | ASTM A671 | CC60 | Cl. 12 Cl. 22 or Cl.32 or Cl.42 | ASTM A671 S2, S7, S14 | | | |
| | ASTM A671 | CC65 | Cl. 12 Cl. 22 or Cl.32 or Cl.42 | ASTM A671 S2, S7, S14 | | | |
| | ASTM A671 | CC70 | Cl. 12 Cl. 22 or Cl.32 or Cl.42 | ASTM A671 S2, S7, S14 | | | |
| Page 1 of 2 | | | | | | | |
| Scope | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | | | | |
| Manufacturing | The longitudinal weld shall be straight and made using the SAW process. The weld metal shall be mild steel analysis A-No.1 per ASME BPVC Sec. IX, Table QW-442. | | | | | | |
| Chemical Composition | C ≤ 0.23 %, S ≤ 0.020 %, P ≤ 0.025 %, CE ≤ 0.43 % Microalloying elements (Nb, V, Ti, B) shall not be deliberately added. | | | | | | |
| Heat Treatment | During the heat treatment process, pipes shall be placed in such a way as to ensure free circulation around each pipe including any quenching operation. | | | | | | |
| Impact Testing/ Toughness testing | Impact testing is required for thickness ≥ 6 mm (0.236 in); for pipes with a weld end, the weld end thickness shall govern. The test temperature shall be minus 46 °C (-50 °F). The minimum absorbed energy for full size specimens shall be 27 J (20 ft lbf) average and 20 J (15 ft lbf) single. | | | | | | |
| Extent of Testing | For products delivered in the tempered condition, the minimum tempering temperature shall be 620 °C (1 148 °F). Impact testing per ASTM A671 supplementary requirement S2, as modified by this MDS, shall also be carried out per lot (ASTM A671 supplementary requirement S14 shall apply for lot definition). | | | | | | |
| Non-Destructive Testing | ASTM A671 supplementary requirement S7 shall apply. | | | | | | |
| Repair of Defects | Weld repair of the base material is not permitted. Repairs to weld metal are acceptable in accordance with the standard specification and shall meet the chemistry requirements of the original manufacturing weld. | | | | | | |
| Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^{a, b} | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of ISO 15156 /NACE MR0175 or ISO 17945 /NACE MR0103, and the following additional requirements to the MDS: <u>Chemical composition</u> S ≤ 0.003 % Ni < 1.0 % for the weld metal <u>Hardness testing</u> – Welding procedure qualification testing for manufacturing and any repair welding shall meet the requirements of NACE MR0175-2 /ISO 15156-2 section 7.3.3, using Vickers method, with a maximum hardness of 250HV. – Production testing shall be performed on one length of pipe per lot as follows: • Vickers hardness traverse shall be made across the base material, HAZ and weld metal at both ends of the pipe to include the centre of the pipe wall and 1.0 mm - 2.0 mm (0.04 in - 0.08 in) below the internal and external surfaces, with a maximum hardness of 250HV. | | | | | | |

Material Data Sheet **MDS No. IC102 / IC102S^a / IC102SH^b** **Rev. 01**

TYPE OF MATERIAL: Impact tested carbon steel

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|---------------------|-----------------|--------------|------------------------------------|----------------------------------|
| Welded pipes | ASTM A671 | CC60 | Cl. 12 Cl. 22 or Cl.32 or Cl.42 | ASTM A671 S2, S7, S14 |
| | ASTM A671 | CC65 | Cl. 12 Cl. 22 or Cl.32 or Cl.42 | ASTM A671 S2, S7, S14 |
| | ASTM A671 | CC70 | Cl. 12 Cl. 22 or Cl.32 or Cl.42 | ASTM A671 S2, S7, S14 |

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| Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^{a, b} | <p><u>HIC testing and UT examination</u></p> <p>When suffix SH applies, one finished pipe per ASTM A671 S14 (lot) shall be tested as follows:</p> <ul style="list-style-type: none"> - HIC testing: <ul style="list-style-type: none"> • HIC testing in accordance with NACE TM0284, using Test Solution A. • Acceptance criteria per specimen shall be CLR ≤ 15 %, CTR ≤ 5 %, CSR ≤ 2 %. • Maximum individual crack length shall be reported for each section. - UT examination: <ul style="list-style-type: none"> • ASTM A671, S11 shall apply. |
| | The material shall be traceable in accordance with ISO 15156-2 /NACE MR0175-2 section 9 and this MDS. |

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| Marking | The pipes shall be marked to ensure full traceability to melt and heat treatment lot. |
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| Certification | <p>The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser.</p> <p>The inspection documents shall be issued in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification.</p> <p>The inspection documents shall include the following information:</p> <ul style="list-style-type: none"> - Heat treatment condition. For tempered condition, tempering temperature shall be stated. |
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^a The supplementary suffix “S” shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service, but excluding HIC testing and UT examination.

^b The supplementary suffix “SH” shall be used to designate a material delivered in accordance with the MDS including the additional supplementary requirements for sour service plus HIC testing and UT examination.

Material Data Sheet **MDS No. IC103 / IC103S^a / IC103SH^b** **Rev. 01**

| TYPE OF MATERIAL: Impact tested carbon steel | | | | | | | | | | | | | | | | | | | | | |
|---|---|--------------------|-------------------------|----------------------------------|-----------------|-------------------|--|--------------------|--------------------|------------------------|------|-------|--------|-----------------------------|--|---------------------|-------|--|---------------------|---|--|
| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT | | | | | | | | | | | | | | | | | |
| Wrought fittings | ASTM A420 | WPL6 | - | ASTM A960 S51, S53, S57, S69 | | | | | | | | | | | | | | | | | |
| | ASTM A420 | WPL6W | - | ASTM A960 S51, S53, S57, S69 | | | | | | | | | | | | | | | | | |
| Page 1 of 2 | | | | | | | | | | | | | | | | | | | | | |
| Scope | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | | | | | | | | | | | | | | | | | | |
| Chemical Composition | C ≤ 0.23 %, S ≤ 0.020 %, P ≤ 0.025 %, CE ≤ 0.43 % Microalloying elements (Nb, V, Ti, B) shall not be deliberately added. | | | | | | | | | | | | | | | | | | | | |
| Heat Treatment | During the heat treatment process, fittings shall be placed in such a way as to ensure free circulation around each fitting including any quenching operation. All hot formed or forged fittings, including those manufactured by locally heating a portion of the fitting stock, shall be heat treated after manufacture. For products delivered in the tempered condition, the minimum tempering temperature shall be 620 °C (1 148 °F). | | | | | | | | | | | | | | | | | | | | |
| Tensile Testing | ASTM A960 supplementary requirement S51 shall apply as amended by this MDS. Tensile testing shall be carried out on specimens cut from a fitting where dimensions permit. When removal of specimens is not possible due to the size of the fitting, a prolongation or a length of starting material that has been heat treated in the same heat treatment load as the fittings it represents shall be used. | | | | | | | | | | | | | | | | | | | | |
| Impact Testing/ Toughness testing | Impact testing is required for thickness ≥ 6 mm (0.236 in); for fittings with a weld end, the weld end thickness shall govern. The test temperature shall be minus 46 °C (-50 °F). The minimum absorbed energy for full size specimens shall be 27 J (20 ft lbf) average and 20 J (15 ft lbf) single. | | | | | | | | | | | | | | | | | | | | |
| Hardness testing | ASTM A960 supplementary requirement S57 shall apply with the following requirements: hardness testing shall be carried out on a minimum two fittings, including parent material, weld and HAZ, for each test lot, and shall not exceed 197HBW. | | | | | | | | | | | | | | | | | | | | |
| Extent of Testing | Impact testing shall also be carried out for each heat and heat treatment load. | | | | | | | | | | | | | | | | | | | | |
| Non-Destructive Testing | UT is not acceptable in-lieu of RT. <u>Magnetic particle testing</u> ASTM A960 Supplementary requirement S53 and S69 shall apply as amended by this MDS: <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th rowspan="2">NDE Requirement</th> <th colspan="2">Nominal Thickness</th> </tr> <tr> <th>< 12.7 mm (1/2 in)</th> <th>≥ 12.7 mm (1/2 in)</th> </tr> </thead> <tbody> <tr> <td>Frequency^a</td> <td style="text-align: center;">10 %</td> <td style="text-align: center;">100 %</td> </tr> <tr> <td>Method</td> <td colspan="2" style="text-align: center;">ASME BPVC Sec. V, Article 7</td> </tr> <tr> <td>Extent^b</td> <td colspan="2" style="text-align: center;">100 %</td> </tr> <tr> <td>Acceptance criteria</td> <td colspan="2" style="text-align: center;">ASME BPVC Sec. VIII, Div. 1, Appendix 6</td> </tr> </tbody> </table> <p>NOTE The testing shall be carried out after machining, if applicable. Non-machined surfaces shall be cleaned prior to the testing.</p> <p>^a Frequency of inspection 100 % means that each item shall be examined. When random examination (10 %) is specified, a minimum of one item per lot in any purchase order shall be examined. The test lot shall be as defined for mechanical testing.</p> <p>^b All accessible internal and external surfaces shall be examined.</p> | | | | NDE Requirement | Nominal Thickness | | < 12.7 mm (1/2 in) | ≥ 12.7 mm (1/2 in) | Frequency ^a | 10 % | 100 % | Method | ASME BPVC Sec. V, Article 7 | | Extent ^b | 100 % | | Acceptance criteria | ASME BPVC Sec. VIII, Div. 1, Appendix 6 | |
| NDE Requirement | Nominal Thickness | | | | | | | | | | | | | | | | | | | | |
| | < 12.7 mm (1/2 in) | ≥ 12.7 mm (1/2 in) | | | | | | | | | | | | | | | | | | | |
| Frequency ^a | 10 % | 100 % | | | | | | | | | | | | | | | | | | | |
| Method | ASME BPVC Sec. V, Article 7 | | | | | | | | | | | | | | | | | | | | |
| Extent ^b | 100 % | | | | | | | | | | | | | | | | | | | | |
| Acceptance criteria | ASME BPVC Sec. VIII, Div. 1, Appendix 6 | | | | | | | | | | | | | | | | | | | | |
| Repair of Defects | Weld repair of the base material is not permitted. Repairs to weld metal are acceptable in accordance with the standard specification and shall meet the chemistry requirements of the original manufacturing weld. | | | | | | | | | | | | | | | | | | | | |

Material Data Sheet **MDS No. IC103 / IC103S^a / IC103SH^b** **Rev. 01**

TYPE OF MATERIAL: Impact tested carbon steel

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|------------------|-----------|-------|------------------|------------------------------|
| Wrought fittings | ASTM A420 | WPL6 | - | ASTM A960 S51, S53, S57, S69 |
| | ASTM A420 | WPL6W | - | ASTM A960 S51, S53, S57, S69 |

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| <p>Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^{a, b}</p> | <p>When sour service requirements are specified by the purchaser, the material shall conform to the requirements of ISO 15156 /NACE MR0175 or ISO 17945 /NACE MR0103, and the following additional requirements to the MDS:</p> <p><u>Chemical composition</u></p> <ul style="list-style-type: none"> - S ≤ 0.010 % for WPL6 and WPL6W fittings made from products other than flat-rolled or forged - S ≤ 0.003 % for WPL6W fitting made from flat-rolled products - S ≤ 0.020 % for WPL6 fitting made from forging or hot rolled/wrought bar - Ni < 1.0 % for the weld metal of WPL6W fittings <p><u>Hardness testing</u></p> <p>For WPL6W fittings, in addition to the hardness testing requirement in the MDS, welding procedure qualification testing for manufacturing and any repair welding shall meet the requirements of NACE MR0175-2 /ISO 15156-2 section 7.3.3, using Vickers method, with a maximum hardness of 250HV.</p> <p><u>HIC testing and UT examination</u></p> <p>When suffix SH applies, one finished WPL6W fitting made from flat-rolled products per lot shall be tested as follows:</p> <ul style="list-style-type: none"> - HIC testing: <ul style="list-style-type: none"> • HIC testing in accordance with NACE TM0284, using Test Solution A. • Acceptance criteria per specimen shall be CLR ≤ 15 %, CTR ≤ 5 %, CSR ≤ 2 %. • Maximum individual crack length shall be reported for each section. - UT examination of flat-rolled product before manufacture: <ul style="list-style-type: none"> • ASTM A578 S1, S2.1 shall apply. <p>The material shall be traceable in accordance with ISO 15156-2 /NACE MR0175-2 section 9 and this MDS.</p> |
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| Marking | The fittings shall be marked to ensure full traceability to melt and heat treatment lot. |
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| Certification | <p>The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser.</p> <p>The inspection documents shall be issued in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification.</p> <p>The inspection documents shall include the following information:</p> <ul style="list-style-type: none"> - Heat treatment condition. For tempered condition, tempering temperature shall be stated. |
|----------------------|--|

^a The supplementary suffix “S” shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service, but excluding HIC testing and UT examination.

^b The supplementary suffix “SH” shall be used to designate a material delivered in accordance with the MDS including the additional supplementary requirements for sour service plus HIC testing and UT examination.

Material Data Sheet **MDS No. IC104 / IC104S^a** **Rev. 01**

TYPE OF MATERIAL: Impact tested carbon steel

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|--------------|-----------|-------|------------------|-------------------------------|
| Forgings | ASTM A350 | LF2 | Class 1 | ASTM A350 S6 ASTM A961 S55 |
| | ASTM A350 | LF6 | Class 1 or 2 | ASTM A350 S6 ASTM A961 S55 |

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Scope This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification.

Chemical Composition Supplementary requirement ASTM A350 S6 applies with the following restrictions:
 $C \leq 0.23 \%$, $S \leq 0.020 \%$, $P \leq 0.025 \%$, $CE \leq 0.43 \%$
 LF2 forgings: microalloying elements (Nb, V, Ti, B) shall not be deliberately added.

Heat Treatment During the heat treatment process, forgings shall be placed in such a way as to ensure free circulation around each forging including any quenching operation. For products delivered in the tempered condition, the minimum tempering temperature shall be 620 °C (1 148 °F).

Impact Testing/ Toughness testing Impact testing is required for thickness ≥ 6 mm (0.236 in); for forgings with a weld end, the weld end thickness shall govern.
 The test temperature shall be minus 46 °C (-50 °F) for grade LF2 and minus 51 °C (-60 °F) for grade LF6.
 The minimum absorbed energy for full size specimens shall be 27 J (20 ft lbf) average and 20 J (15 ft lbf) single.

Extent of Testing One set of tensile, impact and hardness testing shall be carried out for each heat and heat treatment load. A test lot shall not exceed 2 000 kg (4 400 lb) for forgings with as forged weight up to 50 kg (110 lb), and 5 000 kg (11 000 lb) for forgings with as forged weight > 50 kg (110 lb).

Non-Destructive Testing

Visual inspection
 VT shall be carried out on each forging in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be cleaned prior to the testing.

Magnetic particle testing
 ASTM A961 Supplementary requirement S55 shall apply as amended by this MDS:

| NDE Requirement | Forgings |
|------------------------|---|
| Frequency ^a | 10 % |
| Method | ASME BPVC Sec. V, Article 7 |
| Extent ^b | 100 % |
| Acceptance criteria | ASME BPVC Sec. VIII, Div. 1, Appendix 6 |

NOTE The testing shall be carried out after machining, if applicable. Non-machined surfaces shall be cleaned prior to the testing.

^a For random examination (10 %), a minimum of one item per lot in any purchase order shall be examined. The test lot shall be as defined for mechanical testing.

^b All accessible internal and external surfaces shall be examined.

Valve forgings NDT
 Inspection shall be according to the applicable valve specification.
 If a QSL is not specified by the purchaser, the requirements in this MDS shall apply.

Repair of Defects Weld repair is not permitted.

Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^a

When sour service requirements are specified by the purchaser, the material shall conform to the requirements of ISO 15156 /NACE MR0175 or ISO 17945 /NACE MR0103, and the following additional requirements to the MDS:

Hardness testing
 Production hardness testing shall be performed in accordance with the requirements in ASTM A350.

The material shall be traceable in accordance with ISO 15156-2 /NACE MR0175-2 section 9 and this MDS.

| Material Data Sheet | | MDS No. IC104 / IC104S ^a | | Rev. 01 |
|---|--|-------------------------------------|-------------------------|----------------------------------|
| TYPE OF MATERIAL: <i>Impact tested carbon steel</i> | | | | |
| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
| Forgings | ASTM A350 | LF2 | Class 1 | ASTM A350 S6 ASTM A961 S55 |
| | ASTM A350 | LF6 | Class 1 or 2 | ASTM A350 S6 ASTM A961 S55 |
| Page 2 of 2 | | | | |
| Marking | The forgings shall be marked to ensure full traceability to melt and heat treatment lot. | | | |
| Certification | <p>The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser.</p> <p>The inspection documents shall be issued in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification.</p> <p>The inspection documents shall include the following information:</p> <ul style="list-style-type: none"> - Heat treatment condition. For tempered condition, tempering temperature shall be stated. | | | |
| ^a The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service. | | | | |

Material Data Sheet **MDS No. IC105 / IC105S^a / IC105SH^b** **Rev. 01**

| <i>TYPE OF MATERIAL: Impact tested carbon steel</i> | | | | |
|--|---|--------------|-------------------------|----------------------------------|
| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
| Plates | ASTM A516 | 60 | - | ASTM A516 S5 |
| | ASTM A516 | 65 | - | ASTM A516 S5 |
| | ASTM A516 | 70 | - | ASTM A516 S5 |
| Page 1 of 2 | | | | |
| Scope | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| Chemical Composition | C ≤ 0.23 %, S ≤ 0.020 %, P ≤ 0.025 %, CE ≤ 0.43 % For Grade 60 plate 12.5 mm (1/2 in) thick and thinner, C ≤ 0.21 % Microalloying elements (Nb, V, Ti, B) shall not be deliberately added. | | | |
| Heat Treatment | During the heat treatment process, components shall be placed in such a way as to ensure free circulation around each plate including any quenching operation. | | | |
| Impact Testing/ Toughness testing | Impact testing is required for thickness ≥ 6 mm (0.236 in). The test temperature shall be minus 46 °C (-50 °F). The minimum absorbed energy for full size specimens shall be 27 J (20 ft lbf) average and 20 J (15 ft lbf) single. The test specimen shall be taken in the longitudinal orientation to the final direction of rolling. | | | |
| Non-Destructive Testing | <u>Visual inspection</u> VT shall be carried out on each plate in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be cleaned prior to the testing. <u>Valve plates NDT</u> Inspection of plates for valve parts shall be according to the applicable valve specification. If a QSL is not specified by the purchaser, the requirements in this MDS shall apply. | | | |
| Repair of Defects | Weld repair is not permitted. | | | |
| Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^{a, b} | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of ISO 15156 /NACE MR0175 or ISO 17945 /NACE MR0103, and the following additional requirements to the MDS: <u>Chemical composition</u> S ≤ 0.003 % <u>Hardness testing</u> Production testing shall be performed in accordance with the requirements in ASTM A370/A1058 on one plate per lot. The maximum hardness shall be 22HRC from three readings taken in close proximity at each location. <u>HIC testing and UT examination</u> When suffix SH applies, one plate per lot shall be tested as follows: – HIC testing: <ul style="list-style-type: none"> • HIC testing in accordance with NACE TM0284, using Test Solution A; • Acceptance criteria per specimen shall be CLR ≤ 15 %, CTR ≤ 5 %, CSR ≤ 2 %. • Maximum individual crack length shall be reported for each section. – UT examination: <ul style="list-style-type: none"> • ASTM A578 S1; S2.1 shall apply. The material shall be traceable in accordance with ISO 15156-2 /NACE MR0175-2 section 9 and this MDS. | | | |
| Marking | The plates shall be marked to ensure full traceability to melt and heat treatment lot. | | | |

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| Material Data Sheet | MDS No. IC105 / IC105S^a / IC105SH^b | Rev. 01 |
|----------------------------|---|----------------|

TYPE OF MATERIAL: Impact tested carbon steel

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|---------------|-----------|-------|------------------|---------------------------|
| Plates | ASTM A516 | 60 | - | ASTM A516 S5 |
| | ASTM A516 | 65 | - | ASTM A516 S5 |
| | ASTM A516 | 70 | - | ASTM A516 S5 |

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| Certification | <p>The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser.</p> <p>The inspection documents shall be issued in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification.</p> <p>The inspection documents shall include the following information:</p> <ul style="list-style-type: none"> - Heat treatment condition. For tempered condition, tempering temperature shall be stated. |
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^a The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service, but excluding HIC testing and UT examination.

^b The supplementary suffix "SH" shall be used to designate a material delivered in accordance with the MDS including the additional supplementary requirements for sour service plus HIC testing and UT examination.

Material Data Sheet **MDS No. IC106 / IC106S^a** **Rev. 01**

TYPE OF MATERIAL: *Impact tested carbon steel*

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|--------------|-----------|-------|------------------|---|
| Castings | ASTM A352 | LCC | - | ASTM A352 S4, S5, S23 ASTM A703 S8, S14, S20 |

Page 1 of 3

Scope This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification.

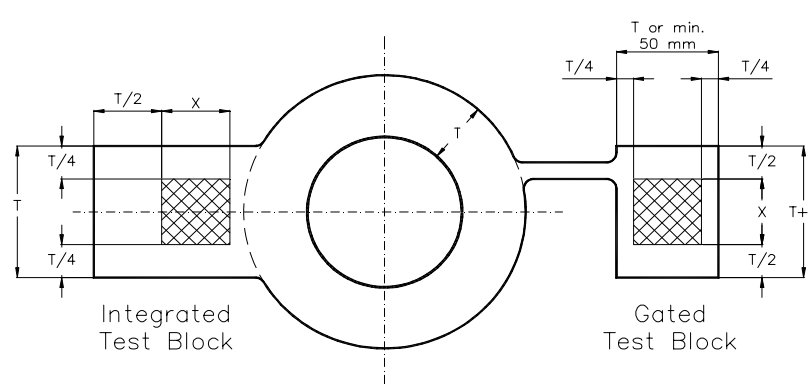
Chemical Composition Supplementary requirement S23 applies with the following restrictions:
 $C \leq 0.23 \%$, $S \leq 0.020 \%$, $P \leq 0.025 \%$, $CE \leq 0.43 \%$
 Microalloying elements (Nb, V, Ti, B) shall not be deliberately added.

Heat Treatment During the heat treatment process, castings shall be placed in such a way as to ensure free circulation around each casting including possible quenching operation.
 For products delivered in the tempered condition, the minimum tempering temperature shall be 620 °C (1 148 °F).

Impact Testing/Toughness testing ASTM A703 Supplementary requirement S8 shall apply. Impact testing shall be performed at a minimum temperature of -46 °C (-50 °F). Acceptance criteria shall be 27 J (20 ft lbf) average, 20 J (15 ft lbf) single.

Extent of Testing ASTM A703 supplementary requirement S14 shall apply.

Test Sampling Test blocks shall be integrally cast or gated onto the casting and shall accompany the castings through all heat treatment operations including any post weld stress relieving.
 Thickness of the test block shall be equal to the thickest part of the casting represented up to a maximum thickness of 100 mm (4 in). For flanged components, the largest flange thickness is the ruling section.
 Dimensions of test blocks and location of test specimens within the test blocks are shown in the figure below for integral and gated test block. The test specimens shall be taken within the cross hatched area. Distance from end of test specimen to end of test block shall minimum be T/4.



Non-Destructive Testing Visual inspection

| NDE requirement | Pilot casting (section 4.8) | Production casting |
|---------------------|---|-------------------------|
| Frequency | Each pilot casting | Each production casting |
| Method | ANSI/MSS SP-55 | |
| Extent | 100 % of all accessible surfaces including welding ends | |
| Acceptance criteria | ANSI/MSS SP-55 | |

NOTE the testing shall be carried out after machining, if applicable. Non-machined surfaces shall be cleaned prior to the testing.

Material Data Sheet **MDS No. IC106 / IC106S^a** **Rev. 01**

TYPE OF MATERIAL: *Impact tested carbon steel*

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|--------------|-----------|-------|------------------|---|
| Castings | ASTM A352 | LCC | - | ASTM A352 S4, S5, S23 ASTM A703 S8, S14, S20 |

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Non-Destructive Testing

Magnetic particle testing

ASTM A352 Supplementary requirement S4 shall apply as amended by this MDS:

| NDE Requirement | Pilot casting (section 4.8) | Production casting ^a |
|------------------------|---|---|
| Frequency ^b | 100 % | 100 % |
| Method | ASME BPVC Sec. V, Article 7 | ASME BPVC Sec. V, Article 7 |
| Extent ^c | 100 % | 100 % |
| Acceptance criteria | ASME BPVC Sec. VIII, Div. 1, Appendix 7 | ASME BPVC Sec. VIII, Div. 1, Appendix 7 |

NOTE The testing shall be carried out after machining, if applicable. Non-machined surfaces shall be cleaned prior to the testing.

^a Production valve castings, MT shall be according to the applicable valve specification. If a QSL is not specified by the purchaser, the requirements in this table shall apply.

^b Frequency of inspection 100 % means that each item shall be examined.

^c All accessible internal and external surfaces shall be examined.

Radiographic testing

ASTM A352 supplementary requirement S5 shall apply as amended by this MDS:

| NDE requirement | Pilot casting (section 4.8) | Production casting | | | | | | |
|------------------------|-----------------------------|--|-------|----------------|-------|---|-------|--------|
| | | Valve castings ^a | | | | Other pressure containing castings ^b | | |
| Frequency ^c | 100 % | NPS | DN | Pressure class | | 100 % | | |
| | | | | ≤ 300 | 600 | | 900 | ≥ 1500 |
| | | < 2 | < 50 | N/R | N/R | | N/R | N/R |
| | | ≥ 2 | ≥ 50 | N/R | 5 % | | 5 % | 5 % |
| | | ≥ 6 | ≥ 150 | N/R | 5 % | | 5 % | 100 % |
| | | ≥ 10 | ≥ 250 | 5 % | 5 % | | 5 % | 100 % |
| | | ≥ 16 | ≥ 400 | 5 % | 5 % | | 100 % | 100 % |
| | | ≥ 20 | ≥ 500 | 5 % | 100 % | 100 % | 100 % | |
| Method | | ASME BPVC Sec. V, Article 2 | | | | | | |
| Extent | | Areas defined by ASME B16.34 for special class valves, at abrupt changes in sections and at the junctions of risers, gates or feeders to the casting | | | | 100 % ^d | | |
| Acceptance criteria | | ASME BPVC Sec. VIII, Div. 1, Appendix 7 | | | | | | |

NOTE N/R means not required, unless specified otherwise by the purchaser.

^a Production valve casting, RT shall be according to the applicable valve specification. If a QSL is not specified by the purchaser, the requirements in this table shall apply.

^b Production casting other than valve casting.

^c Frequency of inspection 100 % means that each item shall be examined. When random examination (5 %) is specified, a minimum of one item per lot of each pattern in any purchase order shall be examined.

^d Production casting other than valve casting, inspection shall include other critical areas as defined in the purchase order and/or applicable product specification or standard. Sketches of the areas to be tested shall be established and agreed with the purchaser.

Material Data Sheet **MDS No. IC106 / IC106S^a** **Rev. 01**

TYPE OF MATERIAL: *Impact tested carbon steel*

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|---------------------|-----------------|--------------|-------------------------|---|
| Castings | ASTM A352 | LCC | - | ASTM A352 S4, S5, S23 ASTM A703 S8, S14, S20 |

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Repair of Defects

ASTM A703 supplementary requirement S20 shall apply with the following additional requirements:

- Repairs as described in ASTM A352 sections 9.3 and 9.4 shall be considered major repairs and shall be documented in accordance with A703 S20.2.
- The repair welding procedure shall be qualified in accordance with ASTM A488 or ISO 11970 and this data sheet using a cast plate.
- Weld repairs are not acceptable for castings that leak during pressure testing.
- Examination of major repair welds on pressure containing parts shall also include RT.

Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^{a, b}

When sour service requirements are specified by the purchaser, the material shall conform to the requirements of ISO 15156 /NACE MR0175 or ISO 17945 /NACE MR0103, and the following additional requirements to the MDS:

Hardness testing

- Production hardness testing shall be performed in accordance with the requirements in ASTM A370/A1058 on the pilot casting and one casting per lot thereafter. The maximum hardness shall be 22HRC from three readings taken in close proximity.
- Welding procedure qualification testing for all repair welding shall meet the requirements of NACE MR0175-2 /ISO 15156-2 section 7.3.3, using Vickers method, with a maximum hardness of 250HV.

The material shall be traceable in accordance with ISO 15156-2 /NACE MR0175-2 section 9 and this MDS.

Marking

The castings shall be marked to ensure full traceability to melt and heat treatment lot.

Certification

The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser.

The inspection documents shall be issued in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification.

The inspection documents shall include the following information:

- Heat treatment condition. For tempered condition, tempering temperature shall be stated.

^a The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

Material Data Sheet **MDS No. IC107 / IC107S^a** **Rev. 01**

TYPE OF MATERIAL: *Impact tested carbon steel*

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|---------------------|-----------------|--------------|-------------------------|----------------------------------|
| Bars | ASTM A696 | B | - | ASTM A696 S5 |
| | ASTM A696 | C | - | ASTM A696 S5 |
| | ASTM A350 | LF2 | Class 1 | |
| | ASTM A350 | LF6 | Class 1 or 2 | |

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| Scope | <p>This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification.</p> <p>This MDS includes additional requirements for valve parts DN 100 (NPS 4) and under manufactured from bars, when permitted by the valve specification.</p> |
| Manufacturing | <p>Bars shall be manufactured to the following requirements:</p> <ul style="list-style-type: none"> - bar forgings as defined in ASTM A788 and certified to ASTM A350; or - hot rolled bars manufactured to ASTM A696 Grade B or C to a maximum outside diameter of 250 mm (10 in). <p>NOTE Cold finishing shall be restricted to turning, grinding or polishing (singly or in combination); cold drawing or cold forming is not permitted.</p> |
| Chemical Composition | <p>C ≤ 0.23 %, S ≤ 0.020 %, P ≤ 0.025 %, CE ≤ 0.43 %</p> <p>Except for ASTM A350 LF6 bars, microalloying elements (Nb, V, Ti, B) shall not be deliberately added.</p> |
| Heat Treatment | <p>Normalized or normalized and tempered or quenched and tempered as a separate operation.</p> <p>For products delivered in the tempered condition, the minimum tempering temperature shall be 620 °C (1 148 °F).</p> <p>During the heat treatment process, bars shall be placed in such a way as to ensure free circulation around each bar including any quenching operation.</p> |
| Impact Testing/ Toughness testing | <p>Impact testing is required for thickness ≥ 6 mm (0.236 in); for bars with a weld end, the weld end thickness shall govern.</p> <p>The test temperature shall be minus 46 °C (-50 °F).</p> <p>The minimum absorbed energy for full size specimens shall be 27 J (20 ft lbf) average and 21 J (15 ft lbf) single.</p> |
| Test Sampling | <p><u>Valve parts manufactured from bar</u></p> <p>Sampling of test specimens for bars intended for machining of valve parts shall comply with the following requirements:</p> <ul style="list-style-type: none"> - The mid-length of the axial tensile and impact test specimens shall be located at a distance equal to the bar outside diameter or minimum of 100 mm (4 in), whichever is the greater, from the end of the bar, and the centreline of the specimen shall be located at a minimum distance of OD/4 from the surface. - The centreline of the tangential tensile and impact test specimens shall be located at a minimum distance of OD/4 from the surface and the mid-point of the specimens at a minimum of 100 mm (4 in) from the end of the bar. - The notch of the impact test specimen shall be located perpendicular to the bar surface. - For bar with outside diameter < 100 mm (4 in): one tensile and one set impact test specimens shall be taken. - For bar with outside diameter ≥ 100 mm (4 in): one tensile and set impact test specimens shall be taken in axial direction of the bar. In addition, one tensile test specimen and one set impact test specimens shall be taken in tangential direction of the bar; the centreline of the tensile test specimen shall be located a minimum of 100 mm (4 in) from the end of the bar. - The specified minimum tensile strength of the referenced standard and impact energies specified in this data sheet shall be met in both directions. |

Material Data Sheet **MDS No. IC107 / IC107S^a** **Rev. 01**

TYPE OF MATERIAL: *Impact tested carbon steel*

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|---------------------|-----------------|--------------|-------------------------|----------------------------------|
| Bars | ASTM A696 | B | - | ASTM A696 S5 |
| | ASTM A696 | C | - | ASTM A696 S5 |
| | ASTM A350 | LF2 | Class 1 | |
| | ASTM A350 | LF6 | Class 1 or 2 | |

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| Non-Destructive Testing | <u>Visual inspection</u> VT shall be carried out on each bar in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be cleaned prior to the testing. | | | | | | | | | | |
|---|--|-----------------------------------|-----------------------------------|------------------------|------|--------|-----------------------------|---------------------|-------|---------------------|---|
| | <u>NDT of valve parts manufactured from bar</u> Inspection shall be according to the applicable valve specification. If a QSL is not specified by the purchaser, the requirements in this MDS shall apply including magnetic particle testing according to the following table. | | | | | | | | | | |
| | <table border="1"> <thead> <tr> <th>NDE Requirement</th> <th>Part manufactured from bar</th> </tr> </thead> <tbody> <tr> <td>Frequency^a</td> <td>10 %</td> </tr> <tr> <td>Method</td> <td>ASME BPVC Sec. V, Article 7</td> </tr> <tr> <td>Extent^b</td> <td>100 %</td> </tr> <tr> <td>Acceptance criteria</td> <td>ASME BPVC Sec. VIII, Div. 1, Appendix 6</td> </tr> </tbody> </table> | NDE Requirement | Part manufactured from bar | Frequency ^a | 10 % | Method | ASME BPVC Sec. V, Article 7 | Extent ^b | 100 % | Acceptance criteria | ASME BPVC Sec. VIII, Div. 1, Appendix 6 |
| | NDE Requirement | Part manufactured from bar | | | | | | | | | |
| | Frequency ^a | 10 % | | | | | | | | | |
| | Method | ASME BPVC Sec. V, Article 7 | | | | | | | | | |
| Extent ^b | 100 % | | | | | | | | | | |
| Acceptance criteria | ASME BPVC Sec. VIII, Div. 1, Appendix 6 | | | | | | | | | | |
| NOTE The testing shall be carried out after machining, if applicable. Non-machined surfaces shall be cleaned prior to the testing. | | | | | | | | | | | |
| ^a For random examination (10 %), a minimum of one item per lot in any purchase order shall be examined. The test lot shall be as defined for mechanical testing. | | | | | | | | | | | |
| ^b All accessible internal and external surfaces shall be examined. | | | | | | | | | | | |

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| Repair of Defects | Weld repair is not permitted. |
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| Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^a | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of ISO 15156 /NACE MR0175 or ISO 17945 /NACE MR0103, and the following additional requirements to the MDS: |
| | <u>Chemical composition</u> S ≤ 0.020 %, Ni < 1.0 % |
| | <u>Hardness testing</u> Production hardness testing shall be performed in accordance with the requirements in ASTM A370/A1058 on the end surface of one bar per lot. The maximum hardness shall be 22HRC from three readings taken in close proximity. The material shall be traceable in accordance with ISO 15156-2 /NACE MR0175-2 section 9 and this MDS. |

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| Marking | The bars shall be marked to ensure full traceability to melt and heat treatment lot. |
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| Certification | The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser. The inspection documents shall be issued in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification. The inspection documents shall include the following information: – Heat treatment condition. For tempered condition, tempering temperature shall be stated. |
|----------------------|--|

^a The supplementary suffix “S” shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

Material Data Sheet**MDS No. ID141 / ID141S^a****Rev. 01**

TYPE OF MATERIAL: Ferritic-Austenitic stainless steel type 22Cr duplex

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|----------------|-----------|------------|------------------|---------------------------|
| Seamless pipes | ASTM A790 | UNS S31803 | - | - |
| | ASTM A790 | UNS S32205 | - | - |

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| Scope | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. |
| Qualification | Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or Norsok M-650. The qualification testing shall meet the requirements of this MDS. |
| Metal Making | The melt shall be refined by AOD or equivalent method. |
| Chemical Composition | UNS S31803: N = 0.14 % - 0.20 % |
| Heat Treatment | The pipes shall be solution annealed followed by rapid cooling. Pipes shall be placed in such a way as to ensure free circulation of heating and cooling media around each pipe during the heat treatment process including quenching. |
| Impact Testing/ Toughness testing | The sampling of test specimens, testing methodology and acceptance criteria shall comply with ISO 17781 QL II. |
| Hardness testing | Hardness testing shall be performed by the Rockwell C method. |
| Corrosion testing | The sampling of test specimens, testing methodology and acceptance criteria shall be in accordance with ISO 17781. |
| Micrographic Examination | The sampling of test specimens, testing methodology and acceptance criteria for microstructural examination including ferrite measurements shall be in accordance with ISO 17781. |
| Extent of Testing | One tensile, one set of impact tests, corrosion test and one micrographic examination including ferrite measurements shall be carried out for each heat and heat treatment lot. |
| Repair of Defects | Weld repair is not permitted. |
| Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^a | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of ISO 15156 /NACE MR0175 or ISO 17945 /NACE MR0103, and the following additional requirements to the MDS: |
| | <u>Hardness testing</u> Production hardness testing shall be performed in accordance with the requirements in ASTM A370/A1058 on one length of pipe per lot. The maximum hardness shall be 28HRC from three readings taken in close proximity. |
| | The material shall be traceable in accordance with ISO 15156-3 /NACE MR0175-3 section 7.2 and this MDS. |
| Surface Treatment and Finish | Finished pipes shall be pickled or bright annealed. |
| Marking | The pipes shall be marked to ensure full traceability to heat and heat treatment lot. |
| Certification | The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser. The inspection documents shall be issued in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification. The inspection documents shall include the following information: <ul style="list-style-type: none"> - The MPS identification or the MCP/R/QTR number used; - Steel manufacturer; - Solution annealing temperature, holding time and quenching medium shall be stated (holding time is not applicable for pipes produced hot finished and direct quenched). |

^a The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

Material Data Sheet**MDS No. ID142 / ID142S^a****Rev. 01**

TYPE OF MATERIAL: Ferritic-Austenitic stainless steel type 22Cr duplex

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|--------------|-----------|------------|---------------------|---------------------------|
| Welded pipes | ASTM A928 | UNS S31803 | Class 1, 3, 4 and 5 | ASTM A928 S3, S4 |
| | ASTM A928 | UNS S32205 | Class 1, 3, 4 and 5 | ASTM A928 S3, S4 |

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| Scope | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | | | | | | | | |
|---|--|-----------------|-------------|------------------------|------|--------|-----------------------------|---------------------|-------|---------------------|---|
| Qualification | Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or Norsok M-650. The qualification testing shall meet the requirements of this MDS. | | | | | | | | | | |
| Metal Making | The melt shall be refined by AOD or equivalent method. | | | | | | | | | | |
| Chemical Composition | UNS S31803: N = 0.14 % - 0.20 % | | | | | | | | | | |
| Welding | The WPS shall be qualified in accordance with ASME BPVC Section IX or ISO 15614-1 and shall include the same examinations as for the production testing and shall fulfil the acceptance criteria of ISO 17781. The qualification shall be carried out on the same material grade (UNS number) as used in production. Change of specific make (brand name) of welding consumables requires requalification. | | | | | | | | | | |
| Heat Treatment | The pipes shall be solution annealed followed by rapid cooling. Pipes shall be placed in such a way as to ensure free circulation of heating and cooling media around each pipe during the heat treatment process including quenching. | | | | | | | | | | |
| Impact Testing/Toughness testing | The sampling of test specimens, testing methodology and acceptance criteria shall comply with ISO 17781 QL II. | | | | | | | | | | |
| Corrosion testing | The sampling of test specimens, testing methodology and acceptance criteria shall be in accordance with ISO 17781. | | | | | | | | | | |
| Micrographic Examination | Supplementary requirement S4 shall apply as modified by this MDS. The sampling of test specimens, testing methodology and acceptance criteria for microstructural examination including ferrite measurements shall be in accordance with ISO 17781. | | | | | | | | | | |
| Extent of Testing | One tensile, one set of impact tests, corrosion test, and one micrographic examination including ferrite measurement including ferrite measurements shall be carried out for each heat and heat treatment lot. A lot of pipe is defined as the quantity of product not exceeding the lot definition in the standard and from the same heat, same processing conditions including weld procedure and same heat treatment load. For continuous furnaces, the lot definition shall comply with the product standards. | | | | | | | | | | |
| Non-Destructive Testing | <p><u>Liquid penetrant testing</u></p> <p>ASTM A928 Supplementary requirement S3 shall apply as amended by this MDS:</p> <table border="1" style="width: 100%; border-collapse: collapse; margin: 10px 0;"> <thead> <tr> <th style="width: 30%;">NDE Requirement</th> <th style="width: 70%;">Welded pipe</th> </tr> </thead> <tbody> <tr> <td>Frequency^a</td> <td style="text-align: center;">10 %</td> </tr> <tr> <td>Method</td> <td style="text-align: center;">ASME BPVC Sec. V, Article 6</td> </tr> <tr> <td>Extent^b</td> <td style="text-align: center;">100 %</td> </tr> <tr> <td>Acceptance criteria</td> <td style="text-align: center;">ASME BPVC Sec. VIII, Div. 1, Appendix 8</td> </tr> </tbody> </table> <p>NOTE The testing shall be carried out after any calibration, pickling/bright annealing and machining. The weld at each end of the examined pipe shall be ground flush in a length of 100 mm (4 in) prior to penetrant testing.</p> <p>^a For random examination (10 %), a minimum of one item per lot in any purchase order shall be examined. The test lot shall be as defined for mechanical testing.</p> <p>^b All external and accessible internal surfaces of the weld shall be examined.</p> | NDE Requirement | Welded pipe | Frequency ^a | 10 % | Method | ASME BPVC Sec. V, Article 6 | Extent ^b | 100 % | Acceptance criteria | ASME BPVC Sec. VIII, Div. 1, Appendix 8 |
| NDE Requirement | Welded pipe | | | | | | | | | | |
| Frequency ^a | 10 % | | | | | | | | | | |
| Method | ASME BPVC Sec. V, Article 6 | | | | | | | | | | |
| Extent ^b | 100 % | | | | | | | | | | |
| Acceptance criteria | ASME BPVC Sec. VIII, Div. 1, Appendix 8 | | | | | | | | | | |

Material Data Sheet **MDS No. ID142 / ID142S^a** **Rev. 01**

TYPE OF MATERIAL: Ferritic-Austenitic stainless steel type 22Cr duplex

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|---------------------|-----------------|--------------|-------------------------|----------------------------------|
| Welded pipes | ASTM A928 | UNS S31803 | Class 1, 3, 4 and 5 | ASTM A928 S3, S4 |
| | ASTM A928 | UNS S32205 | Class 1, 3, 4 and 5 | ASTM A928 S3, S4 |

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Repair of Defects
 Weld repair of base material is not permitted.
 For repair of welds, the requirements for production welding above shall apply to the repair WPS. Repair welds shall be heat treated as per the original production weld.

Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^a
 When sour service requirements are specified by the purchaser, the material shall conform to the requirements of ISO 15156 /NACE MR0175 or ISO 17945 /NACE MR0103, and the following additional requirements to the MDS:
Hardness testing
 - Welding procedure qualification testing for manufacturing and repair welding shall require hardness testing. Hardness surveys shall comply with NACE MR0103 /ISO 17945 section 13.8.2, using Vickers method with a maximum hardness of 310HV (average), 320HV (single value).
 - Production testing shall be performed in accordance with the requirements in ASTM A370/A1058 on one length of pipe per lot. The maximum hardness of the base material, HAZ and weld metal shall be 28HRC from three readings taken in close proximity at each location.
 The material shall be traceable in accordance with ISO 15156-3 /NACE MR0175-3 section 7.2 and this MDS.

Surface Treatment and Finish
 Finished pipes shall be pickled or bright annealed.

Marking
 The pipes shall be marked to ensure full traceability to heat and heat treatment lot.

Certification
 The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser.
 The inspection documents shall be in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification.
 The inspection documents shall include the following information:
 - MPS identification or MCPR/QTR number used;
 - Manufacturer of the starting material;
 - Solution annealing temperature, holding time and quench medium shall be stated.

^a The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| Material Data Sheet | | MDS No. ID143 / ID143S ^a | | Rev. 01 |
|---|---|-------------------------------------|---------------------|---------------------------|
| TYPE OF MATERIAL: Ferritic-Austenitic stainless steel type 22Cr duplex | | | | |
| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
| Wrought fittings | ASTM A815 | UNS S31803 | WP-W, WP-S or WP-WX | ASTM A815 S2, S7 |
| | ASTM A815 | UNS S32205 | WP-W, WP-S or WP-WX | ASTM A815 S2, S7 |
| Page 1 of 3 | | | | |
| Scope | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| Qualification | Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or NORSOK M-650. The qualification testing shall meet the requirements of this MDS. | | | |
| Metal Making | The melt shall be refined by AOD or equivalent method. | | | |
| Chemical Composition | UNS S31803: N = 0.14 % - 0.20 % | | | |
| Welding | The WPS shall be qualified in accordance with ASME BPVC Sec. IX or ISO 15614-1 and shall include the same examinations as for the base material and shall meet the acceptance criteria of ISO 17781. The qualification shall be carried out on the same material grade (UNS number) as used in production. Change of specific make (brand name) of welding consumables requires requalification. | | | |
| Heat Treatment | The fittings shall be solution annealed followed by water/liquid quenching. Fittings shall be placed in such a way as to ensure free circulation of heating and cooling media around each fitting during the heat treatment process including quenching. | | | |
| Tensile Testing | Supplementary requirement S2 shall apply. Tensile testing shall be carried out on specimens cut from a fitting where dimensions permit. When removal of specimens is not possible due to the size of the fitting, a prolongation or a length of starting material that has been heat treated in the same heat treatment load as the fittings it represents shall be used. | | | |
| Impact Testing/ Toughness testing | The sampling of test specimens, testing methodology and acceptance criteria shall comply with ISO 17781 QL II. | | | |
| Corrosion testing | The sampling of test specimens, testing methodology and acceptance criteria shall be in accordance with ISO 17781. | | | |
| Micrographic Examination | The sampling of test specimens, testing methodology and acceptance criteria for microstructural examination including ferrite measurements shall be in accordance with ISO 17781. | | | |
| Extent of Testing | One tensile, impact tests and corrosion test, and one micrographic examination including ferrite measurement shall be carried out for each lot as defined below. A test lot shall include all fittings from the same heat and heat treatment load, with a wall thickness range of ±5 mm (±0.2 in) and, where applicable, welded with the same WPS. Production hardness testing in accordance with the requirements in ASTM A815 shall be carried out on two fittings per lot. When only one fitting is produced, it shall be hardness tested as required. | | | |

Material Data Sheet **MDS No. ID143 / ID143S^a** **Rev. 01**

TYPE OF MATERIAL: *Ferritic-Austenitic stainless steel type 22Cr duplex*

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|-------------------------|-----------------|--------------|-------------------------|----------------------------------|
| Wrought fittings | ASTM A815 | UNS S31803 | WP-W, WP-S or WP-WX | ASTM A815 S2, S7 |
| | ASTM A815 | UNS S32205 | WP-W, WP-S or WP-WX | ASTM A815 S2, S7 |

Page 2 of 3

| Non-Destructive Testing | <p>Ultrasonic testing is not acceptable as replacement for RT of fittings.</p> <p><u>Liquid penetrant testing</u></p> <p>ASTM A815 Supplementary requirement S7 shall apply as amended by this MDS:</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th rowspan="2">NDE Requirement</th> <th colspan="2">Nominal Thickness</th> </tr> <tr> <th>Seamless fittings</th> <th>Welded fittings^a</th> </tr> </thead> <tbody> <tr> <td>Frequency^b</td> <td style="text-align: center;">10 %</td> <td style="text-align: center;">100 %</td> </tr> <tr> <td>Method</td> <td colspan="2" style="text-align: center;">ASME BPVC Sec. V, Article 6</td> </tr> <tr> <td>Extent^c</td> <td colspan="2" style="text-align: center;">100 %</td> </tr> <tr> <td>Acceptance criteria</td> <td colspan="2" style="text-align: center;">ASME BPVC Sec. VIII, Div. 1, Appendix 8</td> </tr> </tbody> </table> <p>NOTE The testing shall be carried out after machining, if applicable. Non-machined surfaces shall be pickled prior to the testing.</p> <p>^a Welded fittings of size DN > 50 (NPS > 2).</p> <p>^b Frequency of inspection 100 % means that each item shall be examined. When random examination (10 %) is specified, a minimum of one item per lot in any purchase order shall be examined. The test lot shall be as defined for mechanical testing.</p> <p>^c All accessible internal and external surfaces shall be examined. For welded fittings, the testing shall cover the weld only.</p> | NDE Requirement | Nominal Thickness | | Seamless fittings | Welded fittings ^a | Frequency ^b | 10 % | 100 % | Method | ASME BPVC Sec. V, Article 6 | | Extent ^c | 100 % | | Acceptance criteria | ASME BPVC Sec. VIII, Div. 1, Appendix 8 | |
|---|--|------------------------------|-------------------|--|-------------------|------------------------------|------------------------|------|-------|--------|-----------------------------|--|---------------------|-------|--|---------------------|---|--|
| NDE Requirement | Nominal Thickness | | | | | | | | | | | | | | | | | |
| | Seamless fittings | Welded fittings ^a | | | | | | | | | | | | | | | | |
| Frequency ^b | 10 % | 100 % | | | | | | | | | | | | | | | | |
| Method | ASME BPVC Sec. V, Article 6 | | | | | | | | | | | | | | | | | |
| Extent ^c | 100 % | | | | | | | | | | | | | | | | | |
| Acceptance criteria | ASME BPVC Sec. VIII, Div. 1, Appendix 8 | | | | | | | | | | | | | | | | | |
| Repair of Defects | <p>Weld repair of base material is not permitted.</p> <p>For repair of welds, the requirements for production welding shall apply to the repair WPS. Repair welds shall be heat treated as per the original production weld.</p> | | | | | | | | | | | | | | | | | |
| Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^a | <p>When sour service requirements are specified by the purchaser, the material shall conform to the requirements of ISO 15156 /NACE MR0175 or ISO 17945 /NACE MR0103, and the following additional requirements to the MDS:</p> <p><u>Hardness testing</u></p> <ul style="list-style-type: none"> - Welding procedure qualification testing for manufacturing and repair welding shall require hardness testing. Hardness surveys shall comply with NACE MR0103 /ISO 17945 section 13.8.2, using Vickers method with a maximum hardness of 310HV (average), 320HV (single value). - Production testing shall be performed in accordance with the requirements in ASTM A370/A1058 on two fittings per lot. When only one fitting is produced, it shall be hardness tested as required. The maximum hardness of the base material, HAZ and weld metal shall be 28HRC from three readings taken in close proximity at each location. <p>The material shall be traceable in accordance with ISO 15156-3 /NACE MR0175-3 section 7.2 and this MDS.</p> | | | | | | | | | | | | | | | | | |
| Surface Treatment and Finish | <p>Finished fittings shall be pickled. Machined surfaces do not require pickling.</p> | | | | | | | | | | | | | | | | | |
| Marking | <p>The fittings shall be marked to ensure full traceability to heat and heat treatment lot.</p> | | | | | | | | | | | | | | | | | |

| Material Data Sheet | | MDS No. ID143 / ID143S ^a | | Rev. 01 |
|--|--|-------------------------------------|-------------------------|----------------------------------|
| TYPE OF MATERIAL: <i>Ferritic-Austenitic stainless steel type 22Cr duplex</i> | | | | |
| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
| Wrought fittings | ASTM A815 | UNS S31803 | WP-W, WP-S or WP-WX | ASTM A815 S2, S7 |
| | ASTM A815 | UNS S32205 | WP-W, WP-S or WP-WX | ASTM A815 S2, S7 |
| Page 3 of 3 | | | | |
| Certification | <p>The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser.</p> <p>The inspection documents shall be in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification.</p> <p>The inspection documents shall include the following information:</p> <ul style="list-style-type: none"> - MPS identification or MCPR/QTR number used; - Steel manufacturer of the starting material for the finished product; - Solution annealing temperature, holding time and quench medium shall be stated. | | | |
| <p>^a The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.</p> | | | | |

Material Data Sheet **MDS No. ID144 / ID144S^a** **Rev. 01**

TYPE OF MATERIAL: *Ferritic-Austenitic Stainless Steel type 22Cr duplex*

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|--------------|-----------|------------------|------------------|---------------------------|
| Forgings | ASTM A182 | F51 (UNS S31803) | | ASTM A961 S56 |
| | ASTM A182 | F60 (UNS S32205) | | ASTM A961 S56 |

Page 1 of 2

| Scope | <p>This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification.</p> <p>Product covered by this MDS is limited to a maximum thickness of 300 mm (12 in). For thickness exceeding 300 mm (12 in), qualification and specification requirements shall be subject to agreement.</p> | | | | | | | | | | |
|--|--|-----------------|-----------------------|------------------------|------|--------|-----------------------------|---------------------|-------|---------------------|---|
| Qualification | <p>Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or NORSOK M-650. The qualification testing shall meet the requirements of this MDS.</p> | | | | | | | | | | |
| Metal Making | <p>The melt shall be refined by AOD or equivalent method.</p> | | | | | | | | | | |
| Chemical Composition | <p>UNS S31803: N = 0.14 % - 0.20 %</p> | | | | | | | | | | |
| Heat Treatment | <p>The forgings shall be solution annealed followed by water/liquid quenching.</p> <p>Forgings shall be placed in such a way as to ensure free circulation of heating and cooling media around each component during the heat treatment process including quenching.</p> | | | | | | | | | | |
| Impact Testing/ Toughness testing | <p>The sampling of test specimens, testing methodology and acceptance criteria shall comply with ISO 17781 QL II.</p> | | | | | | | | | | |
| Corrosion testing | <p>The sampling of test specimens, testing methodology and acceptance criteria shall be in accordance with ISO 17781 for forging with weld ends. Test specimens shall be taken from the surface and the centre of the forging with no weld ends.</p> | | | | | | | | | | |
| Micrographic Examination | <p>The sampling of test specimens, testing methodology and acceptance criteria for microstructural examination including ferrite measurements shall be in accordance with ISO 17781 for forging with weld ends. Test specimens shall be taken from the surface and the centre of the forging with no weld ends and shall sample an area of 10 mm (0.4 in) by 10 mm (0.4 in) minimum.</p> | | | | | | | | | | |
| Extent of Testing | <p>One tensile, impact tests and corrosion test, and one micrographic examination including ferrite measurement shall be carried out for each heat and heat treatment load.</p> <p>The testing shall be carried out on the forgings with heaviest wall thickness within the heat treatment load.</p> <p>A test lot shall not exceed 2 000 kg (4 400 lb) for forgings with as forged weight up to 50 kg (110 lb), and 5 000 kg (11 000 lb) for forgings with as forged weight > 50 kg (110 lb).</p> | | | | | | | | | | |
| Non-Destructive Testing | <p><u>Visual inspection</u></p> <p>VT shall be carried out on each forging in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be pickled prior to the testing.</p> <p><u>Liquid penetrant testing</u></p> <p>ASTM A961 Supplementary requirement S56 shall apply as amended by this MDS:</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 30%;">NDE Requirement</th> <th style="width: 70%;">Forgings^a</th> </tr> </thead> <tbody> <tr> <td>Frequency^b</td> <td style="text-align: center;">10 %</td> </tr> <tr> <td>Method</td> <td style="text-align: center;">ASME BPVC Sec. V, Article 6</td> </tr> <tr> <td>Extent^c</td> <td style="text-align: center;">100 %</td> </tr> <tr> <td>Acceptance criteria</td> <td style="text-align: center;">ASME BPVC Sec. VIII, Div. 1, Appendix 8</td> </tr> </tbody> </table> <p>NOTE The testing shall be carried out after machining, if applicable. Non-machined surfaces shall be pickled prior to the testing.</p> <p>^a Forgings of size DN > 50 (NPS > 2).</p> <p>^b For random examination (10 %), a minimum of one item per lot in any purchase order shall be examined. The test lot shall be as defined for mechanical testing.</p> <p>^c All accessible internal and external surfaces shall be examined.</p> | NDE Requirement | Forgings ^a | Frequency ^b | 10 % | Method | ASME BPVC Sec. V, Article 6 | Extent ^c | 100 % | Acceptance criteria | ASME BPVC Sec. VIII, Div. 1, Appendix 8 |
| NDE Requirement | Forgings ^a | | | | | | | | | | |
| Frequency ^b | 10 % | | | | | | | | | | |
| Method | ASME BPVC Sec. V, Article 6 | | | | | | | | | | |
| Extent ^c | 100 % | | | | | | | | | | |
| Acceptance criteria | ASME BPVC Sec. VIII, Div. 1, Appendix 8 | | | | | | | | | | |

Material Data Sheet **MDS No. ID144 / ID144S^a** **Rev. 01**

TYPE OF MATERIAL: *Ferritic-Austenitic Stainless Steel type 22Cr duplex*

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|---------------------|-----------------|------------------|-------------------------|----------------------------------|
| Forgings | ASTM A182 | F51 (UNS S31803) | | ASTM A961 S56 |
| | ASTM A182 | F60 (UNS S32205) | | ASTM A961 S56 |

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Non-Destructive Testing *Valve forgings NDT*
 Inspection shall be according to the applicable valve specification.
 If a QSL is not specified by the purchaser, the requirements in this MDS shall apply.

Repair of Defects
 Weld repair is not permitted.

Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^a
 When sour service requirements are specified by the purchaser, the material shall conform to the requirements of ISO 15156 /NACE MR0175 or ISO 17945 /NACE MR0103, and the following additional requirements to the MDS:
Hardness testing
 Production hardness testing shall be performed in accordance with the requirements in ASTM A370/A1058 on two forgings per lot. When only one part is produced, it shall be hardness tested as required. The maximum hardness shall be 28HRC from three readings taken in close proximity.
 The material shall be traceable in accordance with ISO 15156-3 /NACE MR0175-3 section 7.2 and this MDS.

Surface Treatment and Finish
 Finished forgings shall be pickled. Machined surfaces do not require pickling.

Marking
 The forgings shall be marked to ensure full traceability to heat and heat treatment lot.

Certification
 The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser.
 The inspection documents shall be issued in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification.
 The inspection documents shall include the following information:
 - The MPS identification or the MCPR/QTR number used;
 - Steel manufacturer;
 - Solution annealing temperature, holding time and quenching medium shall be stated.

^a The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| Material Data Sheet | | | | |
|---|---|------------|------------------|---------------------------|
| MDS No. ID145 / ID145S ^a | | | Rev. 01 | |
| TYPE OF MATERIAL: Ferritic-Austenitic stainless steel type 22Cr duplex | | | | |
| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
| Plates, sheets, strips | ASTM A240 | UNS S31803 | - | ASTM A240 S1 |
| | ASTM A240 | UNS S32205 | - | ASTM A240 S1 |
| Page 1 of 2 | | | | |
| Scope | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| Qualification | Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or NORSOK M-650. The qualification testing shall meet the requirements of this MDS. | | | |
| Metal Making | The melt shall be refined by AOD or equivalent method. | | | |
| Chemical Composition | UNS S31803: N = 0.14 % - 0.20 % | | | |
| Heat Treatment | The plates shall be solution annealed followed by water/liquid quenching. Plates shall be placed in such a way as to ensure free circulation of heating and cooling media around each plate during the heat treatment process including quenching. | | | |
| Tensile Testing | Tensile test specimens shall be sampled in the transverse orientation to the direction of final rolling. | | | |
| Impact testing/ Toughness testing | The sampling of test specimens, testing methodology and acceptance criteria shall comply with ISO 17781 QL II. | | | |
| Corrosion testing | The sampling of test specimens, testing methodology and acceptance criteria shall be in accordance with ISO 17781. | | | |
| Micrographic Examination | The sampling of test specimens, testing methodology and acceptance criteria for microstructural examination including ferrite measurements shall be in accordance with ISO 17781. | | | |
| Extent of Testing | One tensile, one set of impact tests and corrosion test, and one micrographic examination including ferrite measurement shall be carried out for each heat of steel and heat treatment lot. | | | |
| Non-Destructive Testing | <u>Visual Inspection</u> VT shall be carried out on each plate in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be cleaned prior to the testing. | | | |
| | <u>Valve plate NDT</u> Inspection of plate for valve parts shall be according to the applicable valve specification. If a QSL is not specified by the purchaser, the requirements in this MDS shall apply. | | | |
| Repair of Defects | Weld repair is not permitted. | | | |
| Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^a | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of ISO 15156 /NACE MR0175 or ISO 17945 /NACE MR0103, and the following additional requirements to the MDS: | | | |
| | <u>Hardness testing</u> Production testing shall be performed in accordance with the requirements in ASTM A370/A1058 on one plate per lot. For coil, tests shall be carried out at both ends of the coil. The maximum hardness shall be 28HRC from three readings taken in close proximity at each location. | | | |
| | The material shall be traceable in accordance with ISO 15156-3 /NACE MR0175-3 section 7.2 and this MDS. | | | |
| Surface Treatment and Finish | Finished plates, sheets or strips shall be pickled. | | | |
| Marking | The plates, sheets or strips shall be marked to ensure full traceability to heat and heat treatment lot. | | | |

| Material Data Sheet | | | | | MDS No. ID145 / ID145S ^a | | Rev. 01 | |
|--|--|------------|------------------|---------------------------|-------------------------------------|--|---------|--|
| TYPE OF MATERIAL: <i>Ferritic-Austenitic stainless steel type 22Cr duplex</i> | | | | | | | | |
| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT | | | | |
| Plates, sheets, strips | ASTM A240 | UNS S31803 | - | ASTM A240 S1 | | | | |
| | ASTM A240 | UNS S32205 | - | ASTM A240 S1 | | | | |
| Page 2 of 2 | | | | | | | | |
| Certification | <p>The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser.</p> <p>The inspection documents shall be in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification.</p> <p>The inspection documents shall include the following information:</p> <ul style="list-style-type: none"> - MPS identification or MCPR/QTR number used; - Steel manufacturer; - Solution annealing temperature, holding time and quench medium shall be stated. | | | | | | | |
| <p>^a The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.</p> | | | | | | | | |

Material Data Sheet **MDS No. ID146 / ID146S^a** **Rev. 01**

TYPE OF MATERIAL: Ferritic -Austenitic Stainless Steel type 22Cr duplex

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|---------------------|-----------------|-----------------|-------------------------|---------------------------------------|
| Castings | ASTM A995 | 4A (UNS J92205) | - | ASTM A995 S5, S6, S11, ASTM A703 S20. |

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| | | | |
|--|--|---|---------------------------|
| Scope | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | |
| Qualification | Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or NORSOK M-650. The qualification testing shall meet the requirements of this MDS. | | |
| Metal Making | The melt shall be refined by AOD or equivalent method. Induction melting of AOD refined ingot or equally refined scrap as permitted by ISO 17782 is regarded to be equivalent to AOD refined materials. | | |
| Chemical Composition | N = 0.14 % - 0.30 % | | |
| Heat Treatment | The castings shall be solution annealed followed by water/liquid quenching. Castings shall be placed in such a way as to ensure free circulation of heating and cooling media around each casting during the heat treatment process including quenching. | | |
| Impact testing/ Toughness testing | The sampling of test specimens, testing methodology and acceptance criteria shall comply with ISO 17781 QL II. | | |
| Corrosion testing | The sampling of test specimens, testing methodology and acceptance criteria shall be in accordance with ISO 17781. | | |
| Micrographic Examination | The sampling of test specimens, testing methodology and acceptance criteria for microstructural examination including ferrite measurements shall be in accordance with ISO 17781. | | |
| Extent of Testing | One tensile, one set of impact tests and corrosion test, and one micrographic examination including ferrite measurement shall be carried out for each heat of steel and heat treatment load (including any PWHT). A test lot shall not exceed 5 000 kg (11 000 lb) in weight. | | |
| Test Sampling | The test blocks shall be in compliance with ISO 17781. | | |
| Non-Destructive Testing | <u>Visual inspection</u> | | |
| | NDE requirement | Pilot casting (section 4.8) | Production casting |
| | Frequency | Each pilot casting | Each production casting |
| | Method | ANSI/MSS SP-55 | |
| | Extent | 100 % of all accessible surfaces including welding ends | |
| | Acceptance criteria | MSS SP-55 | |
| | NOTE The testing shall be carried out after machining, if applicable. Non-machined surfaces shall be cleaned prior to the testing. | | |

Material Data Sheet **MDS No. ID146 / ID146S^a** **Rev. 01**

TYPE OF MATERIAL: Ferritic -Austenitic Stainless Steel type 22Cr duplex

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|--------------|-----------|-----------------|------------------|---------------------------------------|
| Castings | ASTM A995 | 4A (UNS J92205) | - | ASTM A995 S5, S6, S11, ASTM A703 S20. |

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Non-Destructive Testing

Liquid penetrant testing

ASTM A995 Supplementary requirement S6 shall apply as amended by this MDS:

| NDE Requirement | Pilot casting (section 4.8) | Production casting ^a |
|------------------------|---|---|
| Frequency ^b | 100 % | 100 % |
| Method | ASME BPVC Sec. V, Article 6 | ASME BPVC Sec. V, Article 6 |
| Extent ^c | 100 % | 100 % |
| Acceptance criteria | ASME BPVC Sec. VIII, Div. 1, Appendix 7 | ASME BPVC Sec. VIII, Div. 1, Appendix 7 |

NOTE The testing shall be carried out after machining, if applicable. Non-machined surfaces shall be pickled prior to the testing.

^a Production valve castings, PT shall be according to the applicable valve specification. If a QSL is not specified by the purchaser, the requirements in this table shall apply.

^b Frequency of inspection 100 % means that each item shall be examined.

^c All accessible internal and external surfaces shall be examined.

Radiographic testing

ASTM A995 supplementary requirement S5 shall apply as amended by this MDS:

| NDE requirement | Pilot casting (section 4.8) | Production casting | | | | | | |
|------------------------|--|-----------------------------|------------|----------------|--------------------|---|-------|-------------|
| | | Valve castings ^a | | | | Other pressure containing castings ^b | | |
| Frequency ^c | 100 % | NPS | DN | Pressure class | | 100 % | | |
| | | | | ≤ 300 | 600 | | 900 | ≥ 1500 |
| | | < 2 | < 50 | N/R | N/R | | N/R | N/R |
| | | ≥ 2 | ≥ 50 | N/R | 5 % | | 5 % | 5 % |
| | | ≥ 6 | ≥ 150 | N/R | 5 % | | 5 % | 100 % |
| | | ≥ 10 | ≥ 250 | 5 % | 5 % | | 5 % | 100 % |
| | | ≥ 16 | ≥ 400 | 5 % | 5 % | | 100 % | 100 % |
| ≥ 20 | ≥ 500 | 5 % | 100 % | 100 % | 100 % | | | |
| Method | ASME BPVC Sec. V, Article 2 | | | | | | | |
| Extent | Areas defined by ASME B16.34 for special class valves, at abrupt changes in sections and at the junctions of risers, gates or feeders to the casting | | | | 100 % ^d | | | |
| Acceptance criteria | ASME BPVC Sec. VIII, Div. 1, Appendix 7 | | | | | | | |

NOTE N/R means not required, unless specified otherwise by the purchaser.

^a Production valve casting, RT shall be according to the applicable valve specification. If a QSL is not specified by the purchaser, the requirements in this table shall apply.

^b Production casting other than valve casting.

^c Frequency of inspection 100 % means that each item shall be examined. When random examination (5 %) is specified, a minimum of one item per lot of each pattern in any purchase order shall be examined.

^d Production casting other than valve casting, inspection shall include other critical areas as defined in the purchase order and/or applicable product specification or standard. Sketches of the areas to be tested shall be established and agreed with the purchaser.

Material Data Sheet **MDS No. ID146 / ID146S^a** **Rev. 01**

TYPE OF MATERIAL: Ferritic -Austenitic Stainless Steel type 22Cr duplex

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|---------------------|-----------------|-----------------|-------------------------|---------------------------------------|
| Castings | ASTM A995 | 4A (UNS J92205) | - | ASTM A995 S5, S6, S11, ASTM A703 S20. |

Page 3 of 3

| | |
|---|---|
| Repair of Defects | <p>All major repairs as defined by ASTM A995 shall be documented in accordance with ASTM A703 supplementary requirement S20.2.</p> <p>The repair welding procedure shall be qualified in accordance with ASTM A488 or ISO 11970 and the following:</p> <ul style="list-style-type: none"> - welding procedure shall be qualified on the same cast material grade (UNS number) as used in production; - change of specific make of filler metal (brand names) requires requalification for SMAW and FCAW processes; - microstructure examination, ferrite measurement, Charpy V-notch and corrosion tests shall be carried out in accordance with ISO 17781. <p>Examination of major repair welds on pressure containing parts shall also include RT.</p> <p>Weld repairs are not acceptable for castings that leak during pressure testing.</p> <p>Post weld heat treatment is required after all weld repairs.</p> <p>If a minor cosmetic repair is required, heat treatment may be excluded providing the welding procedure meets all the specified microstructural, mechanical and corrosion material requirements of this data sheet in the as-welded condition.</p> |
| Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^a | <p>When sour service requirements are specified by the purchaser, the material shall conform to the requirements of ISO 15156 /NACE MR0175 or ISO 17945 /NACE MR0103, and the following additional requirements to the MDS:</p> <p><u>Hardness testing</u></p> <ul style="list-style-type: none"> - Production hardness testing shall be performed in accordance with the requirements in ASTM A370/A1058 on the pilot casting and one casting per lot thereafter. The maximum hardness shall be 28HRC from three readings taken in close proximity at each location. - Welding procedure qualification testing for all repair welding shall require hardness testing. Hardness surveys shall comply with NACE MR0103 /ISO 17945 section 13.8.2, using Vickers method with a maximum hardness of 310HV (average), 320HV (single value). <p>The material shall be traceable in accordance with ISO 15156-3 /NACE MR0175-3 section 7.2 and this MDS.</p> |
| Surface Treatment and Finish | Finished castings shall be pickled. Machined surfaces do not require pickling. |
| Marking | The castings shall be marked to ensure full traceability to heat and heat treatment lot. |
| Certification | <p>The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser.</p> <p>The inspection documents shall be issued in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification.</p> <p>The inspection documents shall include the following information:</p> <ul style="list-style-type: none"> - The MPS identification or the MCPR/QTR number used; - Steel melting and refining practice; - Solution annealing temperature, holding time and quenching medium shall be stated. |

^a The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

Material Data Sheet **MDS No. ID147 / ID147S^a** **Rev. 01**

TYPE OF MATERIAL: *Ferritic -Austenitic Stainless Steel type 22Cr duplex*

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|---------------------|-----------------|------------------|-------------------------|----------------------------------|
| Bars | ASTM A276 | UNS S31803 | | |
| | ASTM A276 | UNS S32205 | | |
| | ASTM A479 | UNS S31803 | | |
| | ASTM A479 | UNS S32205 | | |
| | ASTM A182 | F51 (UNS S31803) | | |
| | ASTM A182 | F60 (UNS S32205) | | |

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|--|---|
| Scope | <p>This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification.</p> <p>This MDS includes additional requirements for valve parts DN 100 (NPS 4) and under manufactured from bars, when permitted by the valve specification.</p> <p>Product covered by this MDS is limited to a maximum thickness of 300 mm (12 in). For thickness exceeding 300 mm (12 in), qualification and specification requirements shall be subject to agreement.</p> |
| Qualification | Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or NORSOK M-650. The qualification testing shall meet the requirements of this MDS. |
| Metal Making | The melt shall be refined by AOD or equivalent method. |
| Manufacturing | <p>Bars shall be manufactured to the following requirements:</p> <ul style="list-style-type: none"> - bar forgings as defined in ASTM A788 and certified to ASTM A182, or; - hot or cold finished cylindrical shaped bar manufactured to ASTM A276 or A479 with maximum diameter of 300 mm (12 in). <p>NOTE Cold finishing shall be restricted to turning, grinding or polishing (singly or in combination); cold drawing or cold forming is not permitted.</p> |
| Chemical Composition | UNS S31803: N = 0.14 % - 0.20 % |
| Heat Treatment | <p>Bars shall be solution annealed followed by water/liquid quenching.</p> <p>Bars shall be placed in such a way as to ensure free circulation of heating and cooling media around each bar during the heat treatment process including quenching.</p> |
| Tensile Testing | Where tensile testing in both directions is required by this MDS, all tensile tests shall meet the specified properties of the referenced standard specification in both directions. The centreline of tensile specimen shall be located at a distance from the bar OD in accordance with ASTM A370 Annex A. |
| Impact Testing/ Toughness testing | <p>Except as modified in the MDS, sampling and acceptance criteria shall comply with ISO 17781 QL II.</p> <p>Where impact testing in the tangential direction is required by this MDS, the acceptance criteria shall be 45 J (33 ft lbf) average, 35 J (26 ft lbf) minimum single.</p> |
| Corrosion testing | The sampling of test specimens, testing methodology and acceptance criteria shall be in accordance with ISO 17781. Test specimens shall be taken from the surface and the centre of the bar. |
| Micrographic Examination | The sampling of test specimens, testing methodology and acceptance criteria for microstructural examination including ferrite measurements shall be in accordance with ISO 17781. Test specimens shall be taken from the surface and the centre of the bar and sample an area of 10 mm (0.4 in) by 10 mm (0.4 in) minimum. |
| Extent of Testing | Tensile, impact tests and corrosion tests, and one micrographic examination including ferrite measurements shall be carried out for each lot as defined in ASTM A484. |

Material Data Sheet**MDS No. ID147 / ID147S^a****Rev. 01**

TYPE OF MATERIAL: *Ferritic -Austenitic Stainless Steel type 22Cr duplex*

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|--------------|-----------|------------------|------------------|---------------------------|
| Bars | ASTM A276 | UNS S31803 | | |
| | ASTM A276 | UNS S32205 | | |
| | ASTM A479 | UNS S31803 | | |
| | ASTM A479 | UNS S32205 | | |
| | ASTM A182 | F51 (UNS S31803) | | |
| | ASTM A182 | F60 (UNS S32205) | | |

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Test Sampling

The mid-length of axial (longitudinal) and tangential (transverse) specimens shall be located at a distance equal to the bar outside diameter or minimum of 100 mm (4 in) , whichever is the greater, from the end of the bar.

Valve parts manufactured from bar

For bars with outside diameter ≥ 100 mm (4 in) intended for machining of valve parts, in addition to tensile testing and impact testing in the longitudinal direction, one tensile test specimen and one set of three impact test specimens shall be taken in the tangential direction. Acceptance criteria shall comply with this MDS.

Non-Destructive Testing

Visual Inspection

VT shall be carried out on each bar in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be cleaned prior to the testing.

NDT valve parts manufactured from bar

Inspection of valve parts manufactured from bar shall be according to the applicable valve specification. If a QSL is not specified by the purchaser, the requirements in this MDS shall apply including liquid penetrant testing according to the following table.

| NDE Requirement | Part manufactured from bar ^a |
|------------------------|---|
| Frequency ^b | 10 % |
| Method | ASME BPVC Sec. V, Article 6 |
| Extent ^c | 100 % |
| Acceptance criteria | ASME BPVC Sec. VIII, Div. 1, Appendix 8 |

NOTE The testing shall be carried out after machining, if applicable. Non-machined surfaces shall be pickled prior to the testing.

^a Part of size DN > 50 (NPS > 2).

^b For random examination (10 %), a minimum of one item per lot in any purchase order shall be examined. The test lot shall be as defined for mechanical testing.

^c All accessible internal and external surfaces shall be examined.

Repair of Defects

Weld repair is not permitted.

Sour Service (additional metallurgical, manufacturing, testing and certification requirements)

When sour service requirements are specified by the purchaser, the material shall conform to the requirements of ISO 15156 /NACE MR0175 or ISO 17945 /NACE MR0103, and the following additional requirements to the MDS:

Hardness testing

Production hardness testing shall be performed in accordance with the requirements in ASTM A370/A1058 on the end surface of one bar per lot. The maximum hardness shall be 28HRC from three readings taken in close proximity.

The material shall be traceable in accordance with ISO 15156-3 /NACE MR0175-3 section 7.2 and this MDS.

Surface Treatment and Finish

Finished product shall be white pickled.

Marking

The bars shall be marked to ensure full traceability to heat and heat treatment lot.

Material Data Sheet **MDS No. ID147 / ID147S^a** **Rev. 01**

TYPE OF MATERIAL: *Ferritic -Austenitic Stainless Steel type 22Cr duplex*

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|---------------------|-----------------|------------------|-------------------------|----------------------------------|
| Bars | ASTM A276 | UNS S31803 | | |
| | ASTM A276 | UNS S32205 | | |
| | ASTM A479 | UNS S31803 | | |
| | ASTM A479 | UNS S32205 | | |
| | ASTM A182 | F51 (UNS S31803) | | |
| | ASTM A182 | F60 (UNS S32205) | | |

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| Certification | <p>The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser.</p> <p>The inspection documents shall be issued in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification.</p> <p>The inspection documents shall include the following information:</p> <ul style="list-style-type: none"> - The MPS identification or the MCPR/QTR number used; - Steel manufacturer of starting material; - Solution annealing temperature, holding time and quenching medium shall be stated. |
|----------------------|---|

^a The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

Material Data Sheet **MDS No. ID148 / ID148S^a** **Rev. 01**

TYPE OF MATERIAL: Ferritic-Austenitic stainless steel type 22Cr duplex

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|---------------------|-----------------|--------------|-------------------------|----------------------------------|
| Tubes | ASTM A789 | UNS S31803 | | |
| | ASTM A789 | UNS S32205 | | |

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|---|--|
| Scope | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. |
| Qualification | Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or Norsok M-650. The qualification testing shall meet the requirements of this MDS. |
| Metal Making | The melt shall be refined by AOD or equivalent method. |
| Chemical Composition | UNS S31803: N = 0.14 % - 0.20 % |
| Heat Treatment | The tubes shall be solution annealed followed by rapid cooling. Tubes shall be placed in such a way as to ensure free circulation of heating and cooling media around each tube during the heat treatment process including rapid cooling. |
| Impact Testing/ Toughness testing | The sampling of test specimens, testing methodology and the acceptance criteria shall comply with ISO 17781 QL II. |
| Corrosion testing | The sampling of test specimens, testing methodology and acceptance criteria shall be in accordance with ISO 17781. |
| Micrographic Examination | The sampling of test specimens, testing methodology and acceptance criteria for microstructural examination including ferrite measurements shall be in accordance with ISO 17781. |
| Extent of Testing | Tensile testing, one set of impact tests and corrosion test, and one micrographic examination including ferrite measurement shall be carried out for each lot as defined in the standard for mechanical tests. |
| Repair of Defects | Weld repair is not permitted. |
| Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^a | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of ISO 15156 /NACE MR0175 or ISO 17945 /NACE MR0103, and the following additional requirements to the MDS: |
| | <u>Hardness testing</u> Production hardness testing shall be performed in accordance with the requirements in ASTM A370/A1058 on one tube per lot. The maximum hardness shall be 28HRC from three readings taken in close proximity. |
| | The material shall be traceable in accordance with ISO 15156-3 /NACE MR0175-3 section 7.2 and this MDS. |
| Surface Treatment and Finish | Finished tubes shall be pickled or bright annealed. |
| Certification | The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser. The inspection documents shall be in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification. The inspection documents shall include the following information: - MPS identification or MCP/R/QTR number used; - Steel manufacturer of the starting material; - Solution annealing temperature, holding time and quench medium shall be stated. |

^a The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| Material Data Sheet | | MDS No. ID149 / ID149S ^a | | Rev. 01 | | | | | | | | | | |
|---|--|-------------------------------------|-------------------------|----------------------------------|-----------------|--------------------------|------------------------|------|--------|-----------------------------|---------------------|-------|---------------------|---|
| TYPE OF MATERIAL: Ferritic-Austenitic stainless steel type 22Cr duplex | | | | | | | | | | | | | | |
| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT | | | | | | | | | | |
| HIP products | ASTM A988 | UNS S31803 | | ASTM A988 S5 | | | | | | | | | | |
| | ASTM A988 | UNS S32205 | | ASTM A988 S5 | | | | | | | | | | |
| Page 1 of 2 | | | | | | | | | | | | | | |
| Scope | This MDS defines applicable options and/or requirements that supplement or amend the referenced ASTM standard specification. Product covered by this MDS is limited to a maximum thickness of 300 mm (12 in). For thickness exceeding 300 mm (12 in), requirements shall be subject to agreement. | | | | | | | | | | | | | |
| Qualification | Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or NORSOK M-650. The qualification testing shall meet the requirements of this MDS. | | | | | | | | | | | | | |
| Metal Making | Gas atomized powder made from AOD-refined metal. Powder blends shall be a homogenous mixture of powder heats in terms of composition, particle size and other properties. | | | | | | | | | | | | | |
| Chemical Composition | UNS S31803: N = 0.14 % - 0.20 % | | | | | | | | | | | | | |
| Heat Treatment | The HIP product shall be solution annealed followed by water/liquid quenching. Products shall be placed in such a way as to ensure free circulation of heating and cooling media around each fitting during the heat treatment process including quenching. | | | | | | | | | | | | | |
| Impact Testing/ Toughness testing | The sampling of test specimens, testing methodology and the acceptance criteria shall comply with ISO 17781 QL II. | | | | | | | | | | | | | |
| Corrosion testing | The sampling of test specimens, testing methodology and acceptance criteria shall be in accordance with ISO 17781 for HIP product with weld ends. Test specimens shall be taken from the surface and the centre of the product with no weld ends. | | | | | | | | | | | | | |
| Micrographic Examination | The sampling of test specimens, testing methodology and acceptance criteria for microstructural examination including ferrite measurements shall be in accordance with ISO 17781 for HIP product with weld ends. Test specimens shall be taken from the surface and the centre of the product with no weld ends and shall sample an area of 10 mm (0.4 in) by 10 mm (0.4 in) minimum. | | | | | | | | | | | | | |
| Extent of Testing | One tensile, one set of impact tests and corrosion test, and one microstructure examination including ferrite measurement shall be carried out for each lot. A lot shall include all products from a single powder blend, same manufacturing procedure and same heat treatment load. | | | | | | | | | | | | | |
| Non-Destructive Testing | <p><u>Visual inspection</u></p> <p>VT shall be carried out on each item in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be pickled prior to the testing.</p> <p><u>Liquid penetrant testing</u></p> <p>ASTM A988 supplementary requirement S5 shall apply as amended by this MDS:</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 30%;">NDE Requirement</th> <th>HIP product^a</th> </tr> </thead> <tbody> <tr> <td>Frequency^b</td> <td style="text-align: center;">10 %</td> </tr> <tr> <td>Method</td> <td style="text-align: center;">ASME BPVC Sec. V, Article 6</td> </tr> <tr> <td>Extent^c</td> <td style="text-align: center;">100 %</td> </tr> <tr> <td>Acceptance criteria</td> <td style="text-align: center;">ASME BPVC Sec. VIII, Div. 1, Appendix 8</td> </tr> </tbody> </table> <p>NOTE The testing shall be carried out after machining, if applicable. Non-machined surfaces shall be pickled prior to the testing.</p> <p>^a Parts of size DN > 50 (NPS > 2).</p> <p>^b For random examination (10 %), a minimum of one item per lot in any purchase order shall be examined. The test lot shall be as defined for mechanical testing.</p> <p>^c All accessible internal and external surfaces shall be examined.</p> | | | | NDE Requirement | HIP product ^a | Frequency ^b | 10 % | Method | ASME BPVC Sec. V, Article 6 | Extent ^c | 100 % | Acceptance criteria | ASME BPVC Sec. VIII, Div. 1, Appendix 8 |
| NDE Requirement | HIP product ^a | | | | | | | | | | | | | |
| Frequency ^b | 10 % | | | | | | | | | | | | | |
| Method | ASME BPVC Sec. V, Article 6 | | | | | | | | | | | | | |
| Extent ^c | 100 % | | | | | | | | | | | | | |
| Acceptance criteria | ASME BPVC Sec. VIII, Div. 1, Appendix 8 | | | | | | | | | | | | | |
| Repair of Defects | Weld repair is not permitted. | | | | | | | | | | | | | |

| Material Data Sheet | | | | |
|--|---|------------|------------------|---------------------------|
| MDS No. ID149 / ID149S ^a | | | Rev. 01 | |
| TYPE OF MATERIAL: Ferritic-Austenitic stainless steel type 22Cr duplex | | | | |
| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
| HIP products | ASTM A988 | UNS S31803 | | ASTM A988 S5 |
| | ASTM A988 | UNS S32205 | | ASTM A988 S5 |
| Page 2 of 2 | | | | |
| Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^a | <p>When sour service requirements are specified by the purchaser, the material shall conform to the requirements of ISO 15156 /NACE MR0175 or ISO 17945 /NACE MR0103, and the following additional requirements to the MDS:</p> <p><u>Hardness testing</u></p> <p>Production hardness testing shall be performed in accordance with the requirements in ASTM A370/A1058 on two parts per lot. When only one part is produced, it shall be hardness tested as required. The maximum hardness shall be 25HRC from three readings taken in close proximity.</p> <p>The material shall be traceable in accordance with ISO 15156-3 /NACE MR0175-3 section 7.2 and this MDS.</p> | | | |
| Surface Treatment and Finish | Finished components shall be pickled. Machined surfaces do not require pickling. | | | |
| Marking | The powder blend shall have a unique identity marked on the powder container and this identity shall be recorded and maintained throughout production of the product. The components shall be marked to ensure full traceability to lot as defined in this MDS. | | | |
| Certification | <p>The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser.</p> <p>The inspection documents shall be in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification.</p> <p>The inspection documents shall include the following information:</p> <ul style="list-style-type: none"> - MPS identification or MCPR/QTR number used; - Steel manufacturer of the starting material (powder) for the finished product; - Solution annealing temperature, holding time and quench medium shall be stated. | | | |
| <p>^a The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.</p> | | | | |

Material Data Sheet **MDS No. ID251 / ID251S^a** **Rev. 01**

TYPE OF MATERIAL: Ferritic-Austenitic stainless steel type 25Cr duplex

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|---------------------|-----------------|--------------|-------------------------|----------------------------------|
| Seamless pipes | ASTM A790 | UNS S32550 | | |
| | ASTM A790 | UNS S32750 | | |
| | ASTM A790 | UNS S32760 | | |

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|---|---|
| Scope | This MDS defines applicable options and/or requirements that supplement or amend the referenced ASTM standard specification. |
| Qualification | Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or NORSOK M-650. The qualification testing shall meet the requirements of this MDS. |
| Metal Making | The melt shall be refined by AOD or equivalent method. |
| Chemical Composition | PREN ≥ 40.0 |
| Heat Treatment | The pipes shall be solution annealed followed by rapid cooling. Pipes shall be placed in such a way as to ensure free circulation of heating and cooling media around each pipe during the heat treatment process including quenching. |
| Impact Testing/ Toughness testing | The sampling of test specimens, testing methodology and acceptance criteria shall comply with ISO 17781 QL II. |
| Hardness testing | Hardness testing shall be performed by the Rockwell C method. |
| Corrosion testing | The sampling of test specimens, testing methodology and acceptance criteria shall be in accordance with ISO 17781. |
| Micrographic Examination | The sampling of test specimens, testing methodology and acceptance criteria for microstructural examination including ferrite measurements shall be in accordance with ISO 17781. |
| Extent of Testing | One tensile, one set of impact tests and corrosion test, and one microstructure examination including ferrite measurement shall be carried out for each heat and heat treatment lot. |
| Repair of Defects | Weld repair is not permitted. |
| Sour Service (additional metallurgical, manufacturing, testing and certification requirements) | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of ISO 15156 /NACE MR0175 or ISO 17945 /NACE MR0103, and the following additional requirements to the MDS: |
| | <u>Hardness testing</u> Production hardness testing shall be performed in accordance with the requirements in ASTM A370/A1058 on one length of pipe per lot. The maximum hardness shall be 32HRC from three readings taken in close proximity. |
| | The material shall be traceable in accordance with ISO 15156-3 /NACE MR0175-3 section 7.2 and this MDS. |
| Surface Treatment and Finish | Finished pipes shall be pickled or bright annealed. |
| Marking | The pipes shall be marked to ensure full traceability to heat and heat treatment lot. |
| Certification | The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser. The inspection documents shall be in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification. The inspection documents shall include the following information: <ul style="list-style-type: none"> - MPS identification or MCPR/QTR number used; - Steel manufacturer; - Solution annealing temperature, holding time and quench medium shall be stated (holding time is not applicable for pipes produced hot finished and direct quenched). |

^a The supplementary suffix “S” shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| Material Data Sheet | | MDS No. ID252 / ID252S ^a | | Rev. 01 | | | | | | | | | | |
|---|--|-------------------------------------|---------------------|---------------------------|-----------------|-------------|------------------------|------|--------|-----------------------------|---------------------|-------|---------------------|---|
| TYPE OF MATERIAL: Ferritic-Austenitic stainless steel type 25Cr duplex | | | | | | | | | | | | | | |
| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT | | | | | | | | | | |
| Welded pipes | ASTM A928 | UNS S32550 | Class 1, 3, 4 and 5 | ASTM A928 S3, S4 | | | | | | | | | | |
| | ASTM A928 | UNS S32750 | Class 1, 3, 4 and 5 | ASTM A928 S3, S4 | | | | | | | | | | |
| | ASTM A928 | UNS S32760 | Class 1, 3, 4 and 5 | ASTM A928 S3, S4 | | | | | | | | | | |
| Page 1 of 2 | | | | | | | | | | | | | | |
| Scope | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | | | | | | | | | | | |
| Qualification | Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or NORSOK M-650. The qualification testing shall meet the requirements of this MDS. | | | | | | | | | | | | | |
| Metal Making | The melt shall be refined by AOD or equivalent method. | | | | | | | | | | | | | |
| Chemical Composition | PREN ≥ 40.0 | | | | | | | | | | | | | |
| Welding | The WPS shall be qualified in accordance with ASME BPVC Sec. IX or ISO 15614-1 and shall include the same examinations as for the production testing and shall fulfil the acceptance criteria of ISO 17781. The qualification shall be carried out on the same material grade (UNS number) as used in production. Change of specific make (brand name) of welding consumables requires requalification. | | | | | | | | | | | | | |
| Heat Treatment | The pipes shall be solution annealed followed by rapid cooling. Pipes shall be placed in such a way as to ensure free circulation of heating and cooling media around each pipe during the heat treatment process including quenching. | | | | | | | | | | | | | |
| Impact Testing/ Toughness testing | The sampling of test specimens, testing methodology and acceptance criteria shall comply with ISO 17781 QL II. | | | | | | | | | | | | | |
| Corrosion testing | The sampling of test specimens, testing methodology and acceptance criteria shall be in accordance with ISO 17781. | | | | | | | | | | | | | |
| Micrographic Examination | Supplementary requirement S4 shall apply as modified by this MDS. The sampling of test specimens, testing methodology and acceptance criteria for microstructural examination including ferrite measurements shall be in accordance with ISO 17781. | | | | | | | | | | | | | |
| Extent of Testing | One tensile, one set of impact tests and corrosion test, and one microstructure examination including ferrite measurement shall be carried out for each heat and heat treatment lot. A lot of pipe is defined as the quantity of product not exceeding the lot definition in the standard and from the same heat, same processing conditions including weld procedure and same heat treatment load. For continuous furnaces, the lot definition shall comply with the product standards. | | | | | | | | | | | | | |
| Non-Destructive Testing | <p><u>Liquid penetrant testing</u></p> <p>ASTM A928 Supplementary requirement S3 shall apply as amended by this MDS:</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 30%;">NDE Requirement</th> <th>Welded pipe</th> </tr> </thead> <tbody> <tr> <td>Frequency^a</td> <td style="text-align: center;">10 %</td> </tr> <tr> <td>Method</td> <td style="text-align: center;">ASME BPVC Sec. V, Article 6</td> </tr> <tr> <td>Extent^b</td> <td style="text-align: center;">100 %</td> </tr> <tr> <td>Acceptance criteria</td> <td style="text-align: center;">ASME BPVC Sec. VIII, Div. 1, Appendix 8</td> </tr> </tbody> </table> <p>NOTE The testing shall be carried out after any calibration, pickling/bright annealing and machining. The weld at each end of the examined pipe shall be ground flush in a length of 100 mm (4 in) prior to penetrant testing.</p> <p>^a For random examination (10 %), a minimum of one item per lot in any purchase order shall be examined. The test lot shall be as defined for mechanical testing.</p> <p>^b All external and accessible internal surfaces of the weld shall be examined.</p> | | | | NDE Requirement | Welded pipe | Frequency ^a | 10 % | Method | ASME BPVC Sec. V, Article 6 | Extent ^b | 100 % | Acceptance criteria | ASME BPVC Sec. VIII, Div. 1, Appendix 8 |
| NDE Requirement | Welded pipe | | | | | | | | | | | | | |
| Frequency ^a | 10 % | | | | | | | | | | | | | |
| Method | ASME BPVC Sec. V, Article 6 | | | | | | | | | | | | | |
| Extent ^b | 100 % | | | | | | | | | | | | | |
| Acceptance criteria | ASME BPVC Sec. VIII, Div. 1, Appendix 8 | | | | | | | | | | | | | |

Material Data Sheet **MDS No. ID252 / ID252S^a** **Rev. 01**

TYPE OF MATERIAL: Ferritic-Austenitic stainless steel type 25Cr duplex

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|---------------------|-----------------|--------------|-------------------------|----------------------------------|
| Welded pipes | ASTM A928 | UNS S32550 | Class 1, 3, 4 and 5 | ASTM A928 S3, S4 |
| | ASTM A928 | UNS S32750 | Class 1, 3, 4 and 5 | ASTM A928 S3, S4 |
| | ASTM A928 | UNS S32760 | Class 1, 3, 4 and 5 | ASTM A928 S3, S4 |

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Repair of Defects
 Weld repair of base material is not permitted.
 For repair of welds, the requirements for production welding above shall apply to the repair WPS. Repair welds shall be heat treated as per original production weld.

Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^a
 When sour service requirements are specified by the purchaser, the material shall conform to the requirements of ISO 15156 /NACE MR0175 or ISO 17945 /NACE MR0103, and the following additional requirements to the MDS:
Hardness testing
 – Welding procedure qualification testing for manufacturing and repair welding shall require hardness testing. Hardness surveys shall comply with NACE MR0103 /ISO 17945 section 13.8.2, using Vickers method with a maximum hardness of 310HV (average), 320HV (single value).
 – Production testing shall be performed in accordance with the requirements in ASTM A370/A1058 on one length of pipe per lot. The maximum hardness of the base material, HAZ and weld metal shall be 32HRC from three readings taken in close proximity at each location.
 The material shall be traceable in accordance with ISO 15156-3 /NACE MR0175-3 section 7.2 and this MDS.

Surface Treatment and Finish
 Finished pipes shall be pickled or bright annealed.

Marking
 The pipes shall be marked to ensure full traceability to heat and heat treatment lot.

Certification
 The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser.
 The inspection documents shall be in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification.
 The inspection documents shall include the following information:
 – MPS identification or MCPR/QTR number used;
 – Manufacturer of the starting material;
 – Solution annealing temperature, holding time and quench medium shall be stated.

^a The supplementary suffix “S” shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

Material Data Sheet **MDS No. ID253 / ID253S^a** **Rev. 01**

TYPE OF MATERIAL: *Ferritic-Austenitic stainless steel type 25Cr duplex*

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|-------------------------|-----------------|--------------|-------------------------|----------------------------------|
| Wrought fittings | ASTM A815 | UNS S32550 | WP-W, WP-S or WP-WX | ASTM A815 S2, S7 |
| | ASTM A815 | UNS S32750 | WP-W, WP-S or WP-WX | ASTM A815 S2, S7 |
| | ASTM A815 | UNS S32760 | WP-W, WP-S or WP-WX | ASTM A815 S2, S7 |

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| Scope | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. |
| Qualification | Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or NORSOK M-650. The qualification testing shall meet the requirements of this MDS. |
| Metal Making | The melt shall be refined by AOD or equivalent method. |
| Chemical Composition | PREN ≥ 40.0 |
| Welding | The WPS shall be qualified in accordance with ASME BPVC Sec. IX or ISO 15614-1 and shall include the same examinations as for the production testing and shall fulfil the acceptance criteria of ISO 17781. The qualification shall be carried out on the same material grade (UNS number) as used in production. Change of specific make (brand name) of welding consumables requires requalification. |
| Heat Treatment | The fittings shall be solution annealed followed by water/liquid quenching. Fittings shall be placed in such a way as to ensure free circulation of heating and cooling media around each fitting during the heat treatment process including quenching. |
| Tensile Testing | Supplementary requirement S2 shall apply. Tensile testing shall be carried out on specimens cut from a fitting where dimensions permit. When removal of specimens is not possible due to the size of the fitting, a prolongation or a length of starting material that has been heat treated in the same heat treatment load as the fittings it represents shall be used. |
| Impact Testing/ Toughness testing | The sampling of test specimens, testing methodology and acceptance criteria shall comply with ISO 17781 QL II. |
| Corrosion testing | The sampling of test specimens, testing methodology and acceptance criteria shall be in accordance with ISO 17781. |
| Micrographic Examination | The sampling of test specimens, testing methodology and acceptance criteria for microstructural examination including ferrite measurements shall be in accordance with ISO 17781. |
| Extent of Testing | One tensile, impact tests and corrosion test, and one micrographic examination including ferrite measurement shall be carried out for each lot as defined below. A test lot shall include all fittings from the same heat and heat treatment load, with a wall thickness range of ±5 mm (±0.2 in) and, where applicable, welded with the same WPS. Production hardness testing in accordance with the requirements in ASTM A815 shall be carried out on two fittings per lot. When only one fitting is produced, it shall be hardness tested as required. |

Material Data Sheet **MDS No. ID253 / ID253S^a** **Rev. 01**

TYPE OF MATERIAL: *Ferritic-Austenitic stainless steel type 25Cr duplex*

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|-------------------------|-----------------|--------------|-------------------------|----------------------------------|
| Wrought fittings | ASTM A815 | UNS S32550 | WP-W, WP-S or WP-WX | ASTM A815 S2, S7 |
| | ASTM A815 | UNS S32750 | WP-W, WP-S or WP-WX | ASTM A815 S2, S7 |
| | ASTM A815 | UNS S32760 | WP-W, WP-S or WP-WX | ASTM A815 S2, S7 |

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| Non-Destructive Testing | <p>Ultrasonic testing is not acceptable as replacement for RT of fittings.</p> <p><u>Liquid penetrant testing</u></p> <p>ASTM A815 Supplementary requirement S7 shall apply as amended by this MDS:</p> <table border="1" style="width: 100%;"> <thead> <tr> <th rowspan="2">NDE Requirement</th> <th colspan="2">Nominal Thickness</th> </tr> <tr> <th>Seamless fittings</th> <th>Welded fittings^a</th> </tr> </thead> <tbody> <tr> <td>Frequency^b</td> <td>10 %</td> <td>100 %</td> </tr> <tr> <td>Method</td> <td colspan="2">ASME BPVC Sec. V, Article 6</td> </tr> <tr> <td>Extent^c</td> <td colspan="2">100 %</td> </tr> <tr> <td>Acceptance criteria</td> <td colspan="2">ASME BPVC Sec. VIII, Div. 1, Appendix 8</td> </tr> </tbody> </table> <p>NOTE The testing shall be carried out after machining, if applicable. Non-machined surfaces shall be pickled prior to the testing.</p> <p>^a Welded fittings of size DN > 50 (NPS > 2).</p> <p>^b Frequency of inspection 100 % means that each item shall be examined. When random examination (10 %) is specified, a minimum of one item per lot in any purchase order shall be examined. The test lot shall be as defined for mechanical testing.</p> <p>^c All accessible internal and external surfaces shall be examined. For welded fittings, the testing shall cover the weld only.</p> | NDE Requirement | Nominal Thickness | | Seamless fittings | Welded fittings ^a | Frequency ^b | 10 % | 100 % | Method | ASME BPVC Sec. V, Article 6 | | Extent ^c | 100 % | | Acceptance criteria | ASME BPVC Sec. VIII, Div. 1, Appendix 8 | |
|---|---|------------------------------|-------------------|--|-------------------|------------------------------|------------------------|------|-------|--------|-----------------------------|--|---------------------|-------|--|---------------------|---|--|
| NDE Requirement | Nominal Thickness | | | | | | | | | | | | | | | | | |
| | Seamless fittings | Welded fittings ^a | | | | | | | | | | | | | | | | |
| Frequency ^b | 10 % | 100 % | | | | | | | | | | | | | | | | |
| Method | ASME BPVC Sec. V, Article 6 | | | | | | | | | | | | | | | | | |
| Extent ^c | 100 % | | | | | | | | | | | | | | | | | |
| Acceptance criteria | ASME BPVC Sec. VIII, Div. 1, Appendix 8 | | | | | | | | | | | | | | | | | |
| Repair of Defects | <p>Weld repair of base material is not permitted.</p> <p>For repair of welds, the requirements for production welding shall apply to the repair WPS. Repair welds shall be heat treated as per the original production weld.</p> | | | | | | | | | | | | | | | | | |
| Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^a | <p>When sour service requirements are specified by the purchaser, the material shall conform to the requirements of ISO 15156 /NACE MR0175 or ISO 17945 /NACE MR0103, and the following additional requirements to the MDS:</p> <p><u>Hardness testing</u></p> <ul style="list-style-type: none"> - Welding procedure qualification testing for manufacturing and repair welding shall require hardness testing. Hardness surveys shall comply with NACE MR0103 /ISO 17945 section 13.8.2, using Vickers method with a maximum hardness of 310HV (average), 320HV (single value). - Production testing shall be performed in accordance with the requirements in ASTM A370/A1058 on two fittings per lot. When only one fitting is produced, it shall be hardness tested as required. The maximum hardness of the base material, HAZ and weld metal shall be 32HRC from three readings taken in close proximity at each location. <p>The material shall be traceable in accordance with ISO 15156-3 /NACE MR0175-3 section 7.2 and this MDS.</p> | | | | | | | | | | | | | | | | | |
| Surface Treatment and Finish | <p>Finished fittings shall be pickled. Machined surfaces do not require pickling.</p> | | | | | | | | | | | | | | | | | |
| Marking | <p>The fittings shall be marked to ensure full traceability to heat and heat treatment lot.</p> | | | | | | | | | | | | | | | | | |

Material Data Sheet **MDS No. ID253 / ID253S^a** **Rev. 01**

TYPE OF MATERIAL: *Ferritic-Austenitic stainless steel type 25Cr duplex*

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|-------------------------|-----------------|--------------|-------------------------|----------------------------------|
| Wrought fittings | ASTM A815 | UNS S32550 | WP-W, WP-S or WP-WX | ASTM A815 S2, S7 |
| | ASTM A815 | UNS S32750 | WP-W, WP-S or WP-WX | ASTM A815 S2, S7 |
| | ASTM A815 | UNS S32760 | WP-W, WP-S or WP-WX | ASTM A815 S2, S7 |

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| Certification | <p>The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser.</p> <p>The inspection documents shall be in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification.</p> <p>The inspection documents shall include the following information:</p> <ul style="list-style-type: none"> - MPS identification or MCPR/QTR number used; - Steel manufacturer of the starting material for the finished product; - Solution annealing temperature, holding time and quench medium shall be stated. |
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^a The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

Material Data Sheet **MDS No. ID254 / ID254S^a** **Rev. 01**

TYPE OF MATERIAL: *Ferritic -Austenitic Stainless Steel, Type 25Cr duplex*

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|---------------------|-----------------|------------------|-------------------------|----------------------------------|
| Forgings | ASTM A182 | F53 (UNS S32750) | | ASTM A961 S56 |
| | ASTM A182 | F55 (UNS S32760) | | ASTM A961 S56 |
| | ASTM A182 | F61 (UNS S32550) | | ASTM A961 S56 |

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| Scope | <p>This MDS defines applicable options and/or requirements that supplement or amend the referenced ASTM standard specification.</p> <p>Product covered by this MDS is limited to a maximum thickness of 200 mm (8 in). For thickness exceeding 200 mm (8 in), qualification and specification requirements shall be subject to agreement.</p> |
| Qualification | <p>Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or NORSOK M-650. The qualification testing shall meet the requirements of this MDS.</p> |
| Metal Making | <p>The melt shall be refined by AOD or equivalent method.</p> |
| Chemical Composition | <p>PREN ≥ 40.0</p> |
| Heat Treatment | <p>The forgings shall be solution annealed followed by water/liquid quenching.</p> <p>Forgings shall be placed in such a way as to ensure free circulation of heating and cooling media around each forging during the heat treatment process including quenching.</p> |
| Impact Testing/ Toughness testing | <p>The sampling of test specimens, testing methodology and acceptance criteria shall comply with ISO 17781 QLII.</p> |
| Corrosion testing | <p>The sampling of test specimens, testing methodology and acceptance criteria shall be in accordance with ISO 17781 for forging with weld ends. Test specimens shall be taken from the surface and the centre of the forging with no weld ends.</p> |
| Micrographic Examination | <p>The sampling of test specimens, testing methodology and acceptance criteria for microstructural examination including ferrite measurements shall be in accordance with ISO 17781 for forging with weld ends. Test specimens shall be taken from the surface and the centre of the forging with no weld ends and shall sample an area of 10 mm (0.4 in) by 10 mm (0.4 in) minimum.</p> |
| Extent of Testing | <p>One tensile, impact tests and corrosion test, and one micrographic examination including ferrite measurement shall be carried out for each heat and heat treatment load.</p> <p>The testing shall be carried out on the forging with heaviest wall thickness within the heat treatment load.</p> <p>A test lot shall not exceed 2 000 kg (4 400 lb) for forgings with as forged weight up to 50 kg (110 lb), and 5 000 kg (11 000 lb) for forgings with as forged weight > 50 kg (110 lb).</p> |

Material Data Sheet **MDS No. ID254 / ID254S^a** **Rev. 01**

TYPE OF MATERIAL: *Ferritic -Austenitic Stainless Steel, Type 25Cr duplex*

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|--------------|-----------|------------------|------------------|---------------------------|
| Forgings | ASTM A182 | F53 (UNS S32750) | | ASTM A961 S56 |
| | ASTM A182 | F55 (UNS S32760) | | ASTM A961 S56 |
| | ASTM A182 | F61 (UNS S32550) | | ASTM A961 S56 |

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| Non-Destructive Testing | <p><u>Visual inspection</u></p> <p>VT shall be carried out on each forging or bar in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be pickled prior to the testing.</p> <p><u>Liquid penetrant testing</u></p> <p>ASTM A961 Supplementary requirement S56 shall apply as amended by this MDS:</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 30%;">NDE Requirement</th> <th>Forgings^a</th> </tr> </thead> <tbody> <tr> <td>Frequency^b</td> <td style="text-align: center;">10 %</td> </tr> <tr> <td>Method</td> <td style="text-align: center;">ASME BPVC Sec. V, Article 6</td> </tr> <tr> <td>Extent^c</td> <td style="text-align: center;">100 %</td> </tr> <tr> <td>Acceptance criteria</td> <td style="text-align: center;">ASME BPVC Sec. VIII, Div. 1, Appendix 8</td> </tr> </tbody> </table> <p>NOTE The testing shall be carried out after machining, if applicable. Non-machined surfaces shall be pickled prior to the testing.</p> <p>^a Parts of size DN > 50 (NPS > 2).</p> <p>^b For random examination (10 %), a minimum of one item per lot in any purchase order shall be examined. The test lot shall be as defined for mechanical testing.</p> <p>^c All accessible internal and external surfaces shall be examined.</p> <p><u>Valve forgings NDT</u></p> <p>Inspection shall be according to the applicable valve specification.</p> <p>If a QSL is not specified by the purchaser, the requirements in this MDS shall apply.</p> | NDE Requirement | Forgings ^a | Frequency ^b | 10 % | Method | ASME BPVC Sec. V, Article 6 | Extent ^c | 100 % | Acceptance criteria | ASME BPVC Sec. VIII, Div. 1, Appendix 8 |
|--------------------------------|--|-----------------|-----------------------|------------------------|------|--------|-----------------------------|---------------------|-------|---------------------|---|
| NDE Requirement | Forgings ^a | | | | | | | | | | |
| Frequency ^b | 10 % | | | | | | | | | | |
| Method | ASME BPVC Sec. V, Article 6 | | | | | | | | | | |
| Extent ^c | 100 % | | | | | | | | | | |
| Acceptance criteria | ASME BPVC Sec. VIII, Div. 1, Appendix 8 | | | | | | | | | | |

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| Repair of Defects | Weld repair is not permitted. |
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| Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^a | <p>When compliance with sour service requirements is specified by the purchaser, the material shall conform to ISO 15156 /NACE MR0175 or ISO 17945 /NACE MR0103, and the following additional requirements to the MDS:</p> <p><u>Hardness testing</u></p> <p>Production hardness testing shall be performed in accordance with the requirements in ASTM A370/A1058 on two forgings per lot. When only one part is produced, it shall be hardness tested as required. The maximum hardness shall be 32HRC from three readings taken in close proximity.</p> <p>The material shall be traceable in accordance with ISO 15156-3 /NACE MR0175-3 section 7.2 and this MDS.</p> |
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| Marking | The forgings shall be marked to ensure full traceability to heat and heat treatment lot. |
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| Certification | <p>The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser.</p> <p>The inspection documents shall be issued in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification.</p> <p>The inspection documents shall include the following information:</p> <ul style="list-style-type: none"> - The MPS identification or the MCPR/QTR number used; - Steel manufacturer of starting material for the finished product; - Solution annealing temperature, holding time and quenching medium shall be stated. |
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^a The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| Material Data Sheet | | | | |
|---|---|------------|------------------|---------------------------|
| MDS No. ID255 / ID255S ^a | | | Rev. 01 | |
| TYPE OF MATERIAL: <i>Ferritic-Austenitic stainless steel type 25Cr duplex</i> | | | | |
| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
| Plates, sheets, strips | ASTM A240 | UNS S32550 | | ASTM A240 S1 |
| | ASTM A240 | UNS S32750 | | ASTM A240 S1 |
| | ASTM A240 | UNS S32760 | | ASTM A240 S1 |
| Page 1 of 2 | | | | |
| Scope | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| Qualification | Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or NORSOK M-650. The qualification testing shall meet the requirements of this MDS. | | | |
| Metal Making | The melt shall be refined by AOD or equivalent method. | | | |
| Chemical Composition | PREN ≥ 40.0 | | | |
| Heat Treatment | The plates shall be solution annealed followed by water/liquid quenching. Plates shall be placed in such a way as to ensure free circulation of heating and cooling media around each plate during the heat treatment process including quenching. | | | |
| Tensile Testing | Tensile test specimens shall be sampled in the transverse orientation to the direction of final rolling. | | | |
| Impact Testing/ Toughness testing | The sampling of test specimens, testing methodology and acceptance criteria shall comply with ISO 17781 QL II. | | | |
| Corrosion testing | The sampling of test specimens, testing methodology and acceptance criteria shall be in accordance with ISO 17781. | | | |
| Micrographic Examination | The sampling of test specimens, testing methodology and acceptance criteria for microstructural examination including ferrite measurements shall be in accordance with ISO 17781. | | | |
| Extent of Testing | One tensile, one set of impact tests and corrosion test, and one micrographic examination including ferrite measurement shall be carried out for each heat and heat treatment lot. | | | |
| Non-Destructive Testing | <p><u>Visual Inspection</u></p> <p>VT shall be carried out on each plate in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be cleaned prior to the testing.</p> <p><u>Valve plate NDT</u></p> <p>Inspection shall be according to the applicable valve specification. If a QSL is not specified by the purchaser, the requirements in this MDS shall apply.</p> | | | |
| Repair of Defects | Weld repair is not permitted. | | | |
| Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^a | <p>When sour service requirements are specified by the purchaser, the material shall conform to the requirements of ISO 15156 /NACE MR0175 or ISO 17945 /NACE MR0103, and the following additional requirements to the MDS:</p> <p><u>Hardness testing</u></p> <p>Production testing shall be performed in accordance with the requirements in ASTM A370/A1058 on one plate per lot. For coil, tests shall be carried out at both ends of the coil. The maximum hardness shall be 32HRC from three readings taken in close proximity at each location.</p> <p>The material shall be traceable in accordance with ISO 15156-3 /NACE MR0175-3 section 7.2 and this MDS.</p> | | | |
| Surface Treatment and Finish | Finished plates, sheets and strips shall be pickled. | | | |
| Marking | The plates, sheets and strips shall be marked to ensure full traceability to heat and heat treatment lot. | | | |

| Material Data Sheet | | MDS No. ID255 / ID255S ^a | | Rev. 01 |
|--|--|-------------------------------------|-------------------------|----------------------------------|
| TYPE OF MATERIAL: <i>Ferritic-Austenitic stainless steel type 25Cr duplex</i> | | | | |
| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
| Plates, sheets, strips | ASTM A240 | UNS S32550 | | ASTM A240 S1 |
| | ASTM A240 | UNS S32750 | | ASTM A240 S1 |
| | ASTM A240 | UNS S32760 | | ASTM A240 S1 |
| Page 2 of 2 | | | | |
| Certification | <p>The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser.</p> <p>The inspection documents shall be in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification.</p> <p>The inspection documents shall include the following information:</p> <ul style="list-style-type: none"> - MPS identification or MCPR/QTR number used; - Steel manufacturer of the starting material for the finished product; - Solution annealing temperature, holding time and quench medium shall be stated. | | | |
| <p>^a The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.</p> | | | | |

Material Data Sheet**MDS No. ID256 / ID256S^a****Rev. 01**

TYPE OF MATERIAL: *Ferritic -Austenitic Stainless Steel, Type 25Cr duplex*

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|--------------|-----------|-----------------|------------------|--|
| Castings | ASTM A995 | 5A (UNS J93404) | | ASTM A995 S5, S6, S11 ASTM A703 S20 |
| | ASTM A995 | 6A (UNS J93380) | | ASTM A995 S5, S6, S11 ASTM A703 S20 |

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| Scope | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | | | | | | | | | | | | | |
|--|---|---|-----------------------------|--------------------|-----------|--------------------|-------------------------|--------|----------------|--|--------|---|--|---------------------|-----------|--|
| Qualification | Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or Norsok M-650. The qualification testing shall meet the requirements of this MDS. | | | | | | | | | | | | | | | |
| Metal Making | The melt shall be refined by AOD or equivalent method. Induction melting of AOD refined ingot or equally refined scrap as permitted by ISO 17782 is regarded to be equivalent to AOD refined materials. | | | | | | | | | | | | | | | |
| Chemical Composition | PREN ≥ 40.0 | | | | | | | | | | | | | | | |
| Heat Treatment | The castings shall be solution annealed followed by water/liquid quenching. Castings shall be placed in such a way as to ensure free circulation of heating and cooling media around each casting during the heat treatment process including quenching. | | | | | | | | | | | | | | | |
| Impact Testing/ Toughness testing | The sampling of test specimens, testing methodology and acceptance criteria shall comply with ISO 17781 QL II. | | | | | | | | | | | | | | | |
| Corrosion testing | The sampling of test specimens, testing methodology and acceptance criteria shall be in accordance with ISO 17781. | | | | | | | | | | | | | | | |
| Micrographic Examination | The sampling of test specimens, testing methodology and acceptance criteria for microstructural examination including ferrite measurements shall be in accordance with ISO 17781. | | | | | | | | | | | | | | | |
| Extent of Testing | One tensile, one set of impact tests and corrosion test, and one micrographic examination including ferrite measurement shall be carried out for each heat of steel and heat treatment load (including any PWHT). A test lot shall not exceed 5 000 kg (11 000 lb) in weight. | | | | | | | | | | | | | | | |
| Test Sampling | The test blocks shall be in compliance with ISO 17781. | | | | | | | | | | | | | | | |
| Non-Destructive Testing | <i>Visual inspection</i> | | | | | | | | | | | | | | | |
| | <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 33%;">NDE requirement</th> <th style="width: 33%;">Pilot casting (section 4.8)</th> <th style="width: 33%;">Production casting</th> </tr> </thead> <tbody> <tr> <td>Frequency</td> <td style="text-align: center;">Each pilot casting</td> <td style="text-align: center;">Each production casting</td> </tr> <tr> <td>Method</td> <td colspan="2" style="text-align: center;">ANSI/MSS SP-55</td> </tr> <tr> <td>Extent</td> <td colspan="2" style="text-align: center;">100 % of all accessible surfaces including welding ends</td> </tr> <tr> <td>Acceptance criteria</td> <td colspan="2" style="text-align: center;">MSS SP-55</td> </tr> </tbody> </table> | NDE requirement | Pilot casting (section 4.8) | Production casting | Frequency | Each pilot casting | Each production casting | Method | ANSI/MSS SP-55 | | Extent | 100 % of all accessible surfaces including welding ends | | Acceptance criteria | MSS SP-55 | |
| | NDE requirement | Pilot casting (section 4.8) | Production casting | | | | | | | | | | | | | |
| | Frequency | Each pilot casting | Each production casting | | | | | | | | | | | | | |
| | Method | ANSI/MSS SP-55 | | | | | | | | | | | | | | |
| | Extent | 100 % of all accessible surfaces including welding ends | | | | | | | | | | | | | | |
| | Acceptance criteria | MSS SP-55 | | | | | | | | | | | | | | |
| NOTE The testing shall be carried out after machining, if applicable. Non-machined surfaces shall be cleaned prior to the testing. | | | | | | | | | | | | | | | | |

Material Data Sheet **MDS No. ID256 / ID256S^a** **Rev. 01**

TYPE OF MATERIAL: Ferritic -Austenitic Stainless Steel, Type 25Cr duplex

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|--------------|-----------|-----------------|------------------|--|
| Castings | ASTM A995 | 5A (UNS J93404) | | ASTM A995 S5, S6, S11 ASTM A703 S20 |
| | ASTM A995 | 6A (UNS J93380) | | ASTM A995 S5, S6, S11 ASTM A703 S20 |

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| Non-Destructive Testing | <p><u>Liquid penetrant testing</u> ASTM A995 Supplementary requirement S6 shall apply as amended by this MDS:</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 20%;">NDE Requirement</th> <th style="width: 30%;">Pilot casting (section 4.8)</th> <th style="width: 50%;">Production casting^a</th> </tr> </thead> <tbody> <tr> <td>Frequency^b</td> <td style="text-align: center;">100 %</td> <td style="text-align: center;">100 %</td> </tr> <tr> <td>Method</td> <td style="text-align: center;">ASME BPVC Sec. V, Article 6</td> <td style="text-align: center;">ASME BPVC Sec. V, Article 6</td> </tr> <tr> <td>Extent^c</td> <td style="text-align: center;">100 %</td> <td style="text-align: center;">100 %</td> </tr> <tr> <td>Acceptance criteria</td> <td style="text-align: center;">ASME BPVC Sec. VIII, Div. 1, Appendix 7</td> <td style="text-align: center;">ASME BPVC Sec. VIII, Div. 1, Appendix 7</td> </tr> </tbody> </table> <p>NOTE The testing shall be carried out after machining, if applicable. Non-machined surfaces shall be pickled prior to the testing.</p> <p>^a Production valve castings, PT shall be according to the applicable valve specification. If a QSL is not specified by the purchaser, the requirements in this table shall apply.</p> <p>^b Frequency of inspection 100 % means that each item shall be examined.</p> <p>^c All accessible internal and external surfaces shall be examined.</p> | | | | | NDE Requirement | Pilot casting (section 4.8) | Production casting ^a | Frequency ^b | 100 % | 100 % | Method | ASME BPVC Sec. V, Article 6 | ASME BPVC Sec. V, Article 6 | Extent ^c | 100 % | 100 % | Acceptance criteria | ASME BPVC Sec. VIII, Div. 1, Appendix 7 | ASME BPVC Sec. VIII, Div. 1, Appendix 7 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|--------------------------------|--|---|-------|----------------|-------|--------------------|-----------------------------|---|------------------------|-------|-------|--------|---|-----------------------------|---------------------|-------|-------|---------------------|---|---|-----|----|----------------|--|--|-------|--|--|-------|-----|-----|--------|-----|------|-----|-----|-----|-----|-----|------|-----|-----|-----|-----|-----|-------|-----|-----|-----|-------|------|-------|-----|-----|-----|-------|------|-------|-----|-----|-------|-------|------|-------|-----|-------|-------|-------|--------|-----------------------------|--|--|--|--|--|--------|--|--|--|--|--|--------------------|---------------------|---|--|--|--|--|--|
| NDE Requirement | Pilot casting (section 4.8) | Production casting ^a | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Frequency ^b | 100 % | 100 % | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Method | ASME BPVC Sec. V, Article 6 | ASME BPVC Sec. V, Article 6 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Extent ^c | 100 % | 100 % | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Acceptance criteria | ASME BPVC Sec. VIII, Div. 1, Appendix 7 | ASME BPVC Sec. VIII, Div. 1, Appendix 7 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | <p><u>Radiographic testing</u> ASTM A995 supplementary requirement S5 shall apply as amended by this MDS:</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th rowspan="2" style="width: 20%;">NDE requirement</th> <th rowspan="2" style="width: 15%;">Pilot casting (section 4.8)</th> <th colspan="5">Production casting</th> <th rowspan="2" style="width: 15%;">Other pressure containing castings^b</th> </tr> <tr> <th colspan="5">Valve castings^a</th> </tr> <tr> <td rowspan="7">Frequency^c</td> <td rowspan="7" style="text-align: center;">100 %</td> <th style="width: 10%;">NPS</th> <th style="width: 10%;">DN</th> <th colspan="3">Pressure class</th> <td rowspan="7" style="text-align: center;">100 %</td> </tr> <tr> <td></td> <td></td> <th style="width: 10%;">≤ 300</th> <th style="width: 10%;">600</th> <th style="width: 10%;">900</th> <th style="width: 10%;">≥ 1500</th> </tr> <tr> <td style="text-align: center;">< 2</td> <td style="text-align: center;">< 50</td> <td style="text-align: center;">N/R</td> <td style="text-align: center;">N/R</td> <td style="text-align: center;">N/R</td> <td style="text-align: center;">N/R</td> </tr> <tr> <td style="text-align: center;">≥ 2</td> <td style="text-align: center;">≥ 50</td> <td style="text-align: center;">N/R</td> <td style="text-align: center;">5 %</td> <td style="text-align: center;">5 %</td> <td style="text-align: center;">5 %</td> </tr> <tr> <td style="text-align: center;">≥ 6</td> <td style="text-align: center;">≥ 150</td> <td style="text-align: center;">N/R</td> <td style="text-align: center;">5 %</td> <td style="text-align: center;">5 %</td> <td style="text-align: center;">100 %</td> </tr> <tr> <td style="text-align: center;">≥ 10</td> <td style="text-align: center;">≥ 250</td> <td style="text-align: center;">5 %</td> <td style="text-align: center;">5 %</td> <td style="text-align: center;">5 %</td> <td style="text-align: center;">100 %</td> </tr> <tr> <td style="text-align: center;">≥ 16</td> <td style="text-align: center;">≥ 400</td> <td style="text-align: center;">5 %</td> <td style="text-align: center;">5 %</td> <td style="text-align: center;">100 %</td> <td style="text-align: center;">100 %</td> </tr> <tr> <td style="text-align: center;">≥ 20</td> <td style="text-align: center;">≥ 500</td> <td style="text-align: center;">5 %</td> <td style="text-align: center;">100 %</td> <td style="text-align: center;">100 %</td> <td style="text-align: center;">100 %</td> </tr> </thead> <tbody> <tr> <td>Method</td> <td colspan="6" style="text-align: center;">ASME BPVC Sec. V, Article 2</td> </tr> <tr> <td>Extent</td> <td colspan="5" style="text-align: center;">Areas defined by ASME B16.34 for special class valves, at abrupt changes in sections and at the junctions of risers, gates or feeders to the casting</td> <td style="text-align: center;">100 %^d</td> </tr> <tr> <td>Acceptance criteria</td> <td colspan="6" style="text-align: center;">ASME BPVC Sec. VIII, Div. 1, Appendix 7</td> </tr> </tbody> </table> <p>NOTE N/R means not required, unless specified otherwise by the purchaser.</p> <p>^a Production valve casting, RT shall be according to the applicable valve specification. If a QSL is not specified by the purchaser, the requirements in this table shall apply.</p> <p>^b Production casting other than valve casting.</p> <p>^c Frequency of inspection 100 % means that each item shall be examined. When random examination (5 %) is specified, a minimum of one item per lot of each pattern in any purchase order shall be examined.</p> <p>^d Production casting other than valve casting, inspection shall include other critical areas as defined in the purchase order and/or applicable product specification or standard. Sketches of the areas to be tested shall be established and agreed with the purchaser.</p> | | | | | NDE requirement | Pilot casting (section 4.8) | Production casting | | | | | Other pressure containing castings ^b | Valve castings ^a | | | | | Frequency ^c | 100 % | NPS | DN | Pressure class | | | 100 % | | | ≤ 300 | 600 | 900 | ≥ 1500 | < 2 | < 50 | N/R | N/R | N/R | N/R | ≥ 2 | ≥ 50 | N/R | 5 % | 5 % | 5 % | ≥ 6 | ≥ 150 | N/R | 5 % | 5 % | 100 % | ≥ 10 | ≥ 250 | 5 % | 5 % | 5 % | 100 % | ≥ 16 | ≥ 400 | 5 % | 5 % | 100 % | 100 % | ≥ 20 | ≥ 500 | 5 % | 100 % | 100 % | 100 % | Method | ASME BPVC Sec. V, Article 2 | | | | | | Extent | Areas defined by ASME B16.34 for special class valves, at abrupt changes in sections and at the junctions of risers, gates or feeders to the casting | | | | | 100 % ^d | Acceptance criteria | ASME BPVC Sec. VIII, Div. 1, Appendix 7 | | | | | |
| NDE requirement | Pilot casting (section 4.8) | Production casting | | | | | | Other pressure containing castings ^b | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | Valve castings ^a | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Frequency ^c | 100 % | NPS | DN | Pressure class | | | 100 % | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | ≤ 300 | 600 | 900 | | ≥ 1500 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | < 2 | < 50 | N/R | N/R | N/R | | N/R | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | ≥ 2 | ≥ 50 | N/R | 5 % | 5 % | | 5 % | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | ≥ 6 | ≥ 150 | N/R | 5 % | 5 % | | 100 % | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | ≥ 10 | ≥ 250 | 5 % | 5 % | 5 % | | 100 % | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | ≥ 16 | ≥ 400 | 5 % | 5 % | 100 % | | 100 % | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ≥ 20 | ≥ 500 | 5 % | 100 % | 100 % | 100 % | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Method | ASME BPVC Sec. V, Article 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Extent | Areas defined by ASME B16.34 for special class valves, at abrupt changes in sections and at the junctions of risers, gates or feeders to the casting | | | | | 100 % ^d | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Acceptance criteria | ASME BPVC Sec. VIII, Div. 1, Appendix 7 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Material Data Sheet **MDS No. ID256 / ID256S^a** **Rev. 01**

TYPE OF MATERIAL: *Ferritic -Austenitic Stainless Steel, Type 25Cr duplex*

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|---------------------|-----------------|-----------------|-------------------------|--|
| Castings | ASTM A995 | 5A (UNS J93404) | | ASTM A995 S5, S6, S11 ASTM A703 S20 |
| | ASTM A995 | 6A (UNS J93380) | | ASTM A995 S5, S6, S11 ASTM A703 S20 |

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| Repair of Defects | <p>All major repairs as defined by A995 shall be documented in accordance with A703 supplementary requirement S20.2.</p> <p>The repair welding procedure shall be qualified in accordance with ASTM A488 or ISO 11970 and this data sheet:</p> <ul style="list-style-type: none"> - welding procedure shall be qualified on the same cast material grade (UNS number) as used in production; - change of specific make of filler metal (brand names) requires requalification for SMAW and FCAW processes; - microstructure examination, ferrite measurement, Charpy V-notch and corrosion tests shall be carried out in accordance with ISO 17781. <p>Examination of major repair welds on pressure containing parts shall also include RT.</p> <p>Weld repairs are not acceptable for castings that leak during pressure testing.</p> <p>Post weld heat treatment is required after all weld repairs.</p> <p>If a minor cosmetic repair is required, heat treatment may be excluded providing the welding procedure meets all the specified microstructural, mechanical and corrosion material requirements of this data sheet in the as-welded condition.</p> |
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| Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^a | <p>When sour service requirements are specified by the purchaser, the material shall conform to the requirements of ISO 15156 /NACE MR0175 or ISO 17945 /NACE MR0103, and the following additional requirements to the MDS:</p> <p><u>Hardness testing</u></p> <ul style="list-style-type: none"> - Production hardness testing shall be performed in accordance with the requirements in ASTM A370/A1058 on the pilot casting and one casting per lot thereafter. The maximum hardness shall be 32 HRC from three readings taken in close proximity at each location. - Welding procedure qualification testing for all repair welding shall require hardness testing. Hardness surveys shall comply with NACE MR0103 /ISO 17945 section 13.8.2, using Vickers method with a maximum hardness of 310HV (average), 320HV (single value). <p>The material shall be traceable in accordance with ISO 15156-3 /NACE MR0175-3 section 7.2 and this MDS.</p> |
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| Surface Treatment and Finish | Finished castings shall be pickled. Machined surfaces do not require pickling. |
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| Marking | The castings shall be marked to ensure full traceability to heat and heat treatment lot. |
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| Certification | <p>The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser.</p> <p>The inspection documents shall be issued in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification.</p> <p>The inspection documents shall include the following information:</p> <ul style="list-style-type: none"> - The MPS identification or the MCPR/QTR number used; - Steel melting and refining practice; - Solution annealing temperature, holding time and quenching medium shall be stated. |
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^a The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

Material Data Sheet**MDS No. ID257 / ID257S^a****Rev. 01**

TYPE OF MATERIAL: *Ferritic -Austenitic Stainless Steel, Type 25Cr duplex*

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|--------------|-----------|------------------|------------------|---------------------------|
| Bars | ASTM A276 | UNS S32550 | | |
| | ASTM A276 | UNS S32750 | | |
| | ASTM A276 | UNS S32760 | | |
| | ASTM A479 | UNS S32550 | | |
| | ASTM A479 | UNS S32750 | | |
| | ASTM A479 | UNS S32760 | | |
| | ASTM A182 | F53 (UNS S32750) | | |
| | ASTM A182 | F55 (UNS S32760) | | |
| | ASTM A182 | F61 (UNS S32550) | | |

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| Scope | <p>This MDS defines applicable options and/or requirements that supplement or amend the referenced ASTM standard specification.</p> <p>This MDS includes additional requirements for valve parts DN 100 (NPS 4) and under manufactured from bars, when permitted by the valve specification.</p> <p>Product covered by this MDS is limited to a maximum thickness of 200 mm (8 in). For thickness exceeding 200 mm (8 in), qualification and specification requirements shall be subject to agreement.</p> |
| Qualification | Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or Norsok M-650. The qualification testing shall meet the requirements of this MDS. |
| Metal Making | The melt shall be refined by AOD or equivalent method. |
| Manufacturing | <p>Bars shall be manufactured to the following requirements:</p> <ul style="list-style-type: none"> - bar forgings as defined in ASTM A788 and certified to ASTM A182; or - hot or cold finished cylindrical shaped bar manufactured to ASTM A276 or A479 with maximum diameter of 200 mm (8 in). <p>NOTE Cold finishing shall be restricted to turning, grinding or polishing (singly or in combination); cold drawing or cold forming is not permitted.</p> |
| Chemical Composition | PREN ≥ 40.0 |
| Heat Treatment | <p>The bars shall be solution annealed followed by water/liquid quenching</p> <p>Bars shall be placed in such a way as to ensure free circulation of heating and cooling media around each bar during the heat treatment process including quenching.</p> |
| Tensile Testing | Where tensile testing in both directions is required by this MDS, all tensile tests shall meet the specified properties of the referenced standard specification in both directions. The centreline of tensile specimen shall be located at a distance from the bar OD in accordance with ASTM A370 Annex A. |
| Impact Testing/ Toughness testing | Except as modified in the test MDS, sampling and acceptance criteria shall comply with ISO 17781 QL II. Where impact testing in the tangential direction is required by this MDS, the acceptance criteria shall be 45 J (33 ft lbf) average, 35 J (26 ft lbf) minimum single. |
| Corrosion testing | The sampling of test specimens, testing methodology and acceptance criteria shall be in accordance with ISO 17781. Test specimens shall be taken from the surface and the centre of the bar. |
| Micrographic Examination | The sampling of test specimens, testing methodology and acceptance criteria for microstructural examination including ferrite measurements shall be in accordance with ISO 17781. Test specimens shall be taken from the surface and the centre of the bar and sample an area of 10 mm (0.4 in) by 10 mm (0.4 in) minimum. |
| Extent of Testing | Tensile, impact tests and corrosion tests, and one micrographic examination including ferrite measurements shall be carried out for each lot as defined in ASTM A484. |

Material Data Sheet **MDS No. ID257 / ID257S^a** **Rev. 01**

TYPE OF MATERIAL: *Ferritic -Austenitic Stainless Steel, Type 25Cr duplex*

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|---------------------|-----------------|------------------|-------------------------|----------------------------------|
| Bars | ASTM A276 | UNS S32550 | | |
| | ASTM A276 | UNS S32750 | | |
| | ASTM A276 | UNS S32760 | | |
| | ASTM A479 | UNS S32550 | | |
| | ASTM A479 | UNS S32750 | | |
| | ASTM A479 | UNS S32760 | | |
| | ASTM A182 | F53 (UNS S32750) | | |
| | ASTM A182 | F55 (UNS S32760) | | |
| | ASTM A182 | F61 (UNS S32550) | | |

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| Test Sampling | <p>The mid-length of axial (longitudinal) and tangential (transverse) specimens shall be located at a distance equal to the bar outside diameter or minimum of 100 mm (4 in) , whichever is the greater, from the end of the bar.</p> <p><u>Valve parts manufactured from bar</u></p> <p>For bars with outside diameter ≥ 100 mm (4 in) intended for machining of valve parts, in addition to tensile testing and impact testing in the longitudinal direction, one tensile test specimen and one set of three impact test specimens shall be taken in the tangential direction. Acceptance criteria shall comply with this MDS.</p> |
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| Non-Destructive Testing | <p><u>Visual inspection</u></p> <p>VT shall be carried out on each bar in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be cleaned prior to the testing.</p> <p><u>NDT valve parts manufactured from bar</u></p> <p>Inspection of valve parts manufactured from bar shall be according to the applicable valve specification. If a QSL is not specified by the purchaser, the requirements in this MDS shall apply including liquid penetrant testing according to the following table.</p> <table border="1" style="width: 100%;"> <thead> <tr> <th>NDE Requirement</th> <th>Part manufactured from bar^a</th> </tr> </thead> <tbody> <tr> <td>Frequency^b</td> <td>10 %</td> </tr> <tr> <td>Method</td> <td>ASME BPVC Sec. V, Article 6</td> </tr> <tr> <td>Extent^c</td> <td>100 %</td> </tr> <tr> <td>Acceptance criteria</td> <td>ASME BPVC Sec. VIII, Div. 1, Appendix 8</td> </tr> </tbody> </table> <p>NOTE The testing shall be carried out after machining, if applicable. Non-machined surfaces shall be pickled prior to the testing.</p> <p>^a Part of size DN > 50 (NPS > 2).</p> <p>^b For random examination (10 %), a minimum of one item per lot in any purchase order shall be examined. The test lot shall be as defined for mechanical testing.</p> <p>^c All accessible internal and external surfaces shall be examined.</p> | NDE Requirement | Part manufactured from bar^a | Frequency ^b | 10 % | Method | ASME BPVC Sec. V, Article 6 | Extent ^c | 100 % | Acceptance criteria | ASME BPVC Sec. VIII, Div. 1, Appendix 8 |
|--------------------------------|--|------------------------|---|------------------------|------|--------|-----------------------------|---------------------|-------|---------------------|---|
| NDE Requirement | Part manufactured from bar^a | | | | | | | | | | |
| Frequency ^b | 10 % | | | | | | | | | | |
| Method | ASME BPVC Sec. V, Article 6 | | | | | | | | | | |
| Extent ^c | 100 % | | | | | | | | | | |
| Acceptance criteria | ASME BPVC Sec. VIII, Div. 1, Appendix 8 | | | | | | | | | | |

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| Repair of Defects | Weld repair is not permitted. |
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| Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^a | <p>When sour service requirements are specified by the purchaser, the material shall conform to the requirements of ISO 15156 /NACE MR0175 or ISO 17945 /NACE MR0103, and the following additional requirements to the MDS:</p> <p><u>Hardness testing</u></p> <p>Production hardness testing shall be performed in accordance with the requirements in ASTM A370/A1058 on the end surface of one bar per lot. The maximum hardness shall be 32HRC from three readings taken in close proximity.</p> |
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Material Data Sheet **MDS No. ID257 / ID257S^a** **Rev. 01**

TYPE OF MATERIAL: *Ferritic -Austenitic Stainless Steel, Type 25Cr duplex*

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|---------------------|-----------------|------------------|-------------------------|----------------------------------|
| Bars | ASTM A276 | UNS S32550 | | |
| | ASTM A276 | UNS S32750 | | |
| | ASTM A276 | UNS S32760 | | |
| | ASTM A479 | UNS S32550 | | |
| | ASTM A479 | UNS S32750 | | |
| | ASTM A479 | UNS S32760 | | |
| | ASTM A182 | F53 (UNS S32750) | | |
| | ASTM A182 | F55 (UNS S32760) | | |
| | ASTM A182 | F61 (UNS S32550) | | |

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| Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^a | The material shall be traceable in accordance with ISO 15156-3 /NACE MR0175-3 section 7.2 and this MDS. |
| Surface Treatment and Finish | Finished product shall be white pickled. |
| Marking | The bars shall be marked to ensure full traceability to heat and heat treatment lot. |
| Certification | <p>The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser.</p> <p>The inspection documents shall be issued in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification.</p> <p>The inspection documents shall include the following information:</p> <ul style="list-style-type: none"> - The MPS identification or the MCPR/QTR number used; - Steel melting and refining practice; - Solution annealing temperature, holding time and quenching medium shall be stated. |

^a The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| Material Data Sheet | | | | |
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| MDS No. ID258 / ID258S ^a | | | Rev. 01 | |
| TYPE OF MATERIAL: Ferritic-Austenitic stainless steel type 25Cr duplex | | | | |
| Product Form | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
| Tubes | ASTM A789 | UNS S32550 | | |
| | ASTM A789 | UNS S32750 | | |
| | ASTM A789 | UNS S32760 | | |
| Page 1 of 1 | | | | |
| Scope | This MDS defines applicable options and/or requirements that supplement or amend the referenced ASTM standard specification. | | | |
| Qualification | Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or NORSOK M-650. The qualification testing shall meet the requirements of this MDS. | | | |
| Metal Making | The melt shall be refined by AOD or equivalent method. | | | |
| Chemical Composition | PREN ≥ 40.0 | | | |
| Heat Treatment | The tubes shall be solution annealed followed by rapid cooling. Tubes shall be placed in such a way as to ensure free circulation of heating and cooling media around each tube during the heat treatment process including rapid cooling. | | | |
| Impact Testing/ Toughness testing | The sampling of test specimens, testing methodology and the acceptance criteria shall comply with ISO 17781 QL II. | | | |
| Corrosion testing | The sampling of test specimens, testing methodology and acceptance criteria for microstructural examination including ferrite measurements shall be in accordance with ISO 17781. | | | |
| Micrographic Examination | The sampling of test specimens, testing methodology and acceptance criteria for microstructural examination including ferrite measurements shall be in accordance with ISO 17781. | | | |
| Extent of Testing | Tensile testing, one set of impact tests and corrosion test, and one micrographic examination including ferrite measurement shall be carried out for each lot as defined in the standard for mechanical tests. | | | |
| Repair of Defects | Weld repair is not permitted. | | | |
| Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^a | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of ISO 15156 /NACE MR0175 or ISO 17945 /NACE MR0103, and the following additional requirements to the MDS: | | | |
| | <u>Hardness testing</u> Production hardness testing shall be performed in accordance with the requirements in ASTM A370/A1058 on one tube per lot. The maximum hardness shall be 32HRC from three readings taken in close proximity. | | | |
| | The material shall be traceable in accordance with ISO 15156-3 /NACE MR0175-3 section 7.2 and this MDS. | | | |
| Surface Treatment and Finish | Finished tubes shall be pickled or bright annealed. | | | |
| Marking | The tubes shall be marked to ensure full traceability to heat and heat treatment lot. | | | |
| Certification | The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser. The inspection documents shall be in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification. The inspection documents shall include the following information: <ul style="list-style-type: none"> - MPS identification or MCPR/QTR number used; - Steel heat and refining practice; - Solution annealing temperature, holding time and quench medium shall be stated. | | | |
| ^a The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service. | | | | |

Material Data Sheet**MDS No. ID259 / ID259S^a****Rev. 01**

TYPE OF MATERIAL: *Ferritic -Austenitic Stainless Steel, Type 25Cr duplex*

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|---------------------------|-----------------------|------------|------------------|---|
| Bolting (strain hardened) | ASTM A1082 (modified) | UNS S32550 | - | ASTM A1082 S5 or S6 (nuts only), ASTM A962 S66 |
| | ASTM A1082 (modified) | UNS S32760 | - | ASTM A1082 S5 or S6 (nuts only), ASTM A962 S66 |

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| Scope | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. |
| Qualification | Manufacturers and the manufacturing process for bars as pre-material for bolting to this MDS shall be qualified in accordance with ISO 17782 or NORSOK M-650. The qualification testing shall meet the requirements of this MDS. Manufacturers and the manufacturing process for production of bolting that involves any further hot/cold working (except for cold rolling of threads) and/or heat treatment of bar pre-material shall be separately qualified in accordance with ISO 17782 or NORSOK M-650 and this MDS. |
| Metal Making | The melt shall be refined by AOD or equivalent method. |
| Manufacturing | Headed bolts shall be manufactured by machining from A276 Condition S strain hardened bar. No further working of the strain hardened bar is permitted. Nuts shall be machined from solution annealed and water quenched bar or forgings. Threads on studs and bolts may be made by cold rolling or machining. Threads in nuts shall be machined. |
| Chemical Composition | PREN ≥ 40.0 |
| Heat Treatment | No heat treatment of the strain hardened bar and bolting shall be permitted. |
| Tensile Testing | Tensile testing of studs and headed bolt shall be carried out on a sample representing the finished bolting in accordance with ASTM F606 Method 2 or 2A. All tensile tests shall meet the specified properties of ASTM A276 Condition S. |
| Impact Testing/ Toughness testing | Impact testing of bolting shall be carried out in accordance with the requirements in ASTM A962 on a sample representing the finished bolting. Charpy V-notch tests shall be carried out at -46 °C (-50 °F) and the acceptance criteria shall be 45 J (33 ft lbf) average of three specimens, 35 J (26 ft lbf) minimum single specimen. |
| Hardness testing | Maximum hardness of the strain hardened bar shall not exceed the values in ASTM A276 for the specified grades supplied in Condition S. Hardness may be measured at bar outer surface before threading or in area not affected by the thread rolling operation. |
| Proof Load Testing | A1082 S5 shall apply to at least one nut per test lot - the load shall comply with A194 Grade 7. Alternatively, A1082 S6 may be applied as substitute to proof load testing for nuts with size M36 (1½ in) or above; the hardness shall not exceed the values specified in ASTM A276 Condition S for the specified grades. |
| Corrosion testing | Testing shall be carried out on a sample representing the finished bolting. The sampling of test specimens, testing methodology and acceptance criteria shall be in accordance with the principles in ISO 17781. |
| Micrographic Examination | Testing shall be carried out on a sample representing the finished bolting. The sampling of test specimens, testing methodology and acceptance criteria for microstructural examination including ferrite measurements shall be in accordance with the principles in ISO 17781. |
| Extent of Testing | One tensile, one set of impact tests and corrosion test, and one micrographic examination including ferrite measurement shall be carried out for each test lot where a test lot is as-defined in ASTM A962 for non-heat treated, strain hardened bolting including the same lot for the bar material. |

Material Data Sheet **MDS No. ID259 / ID259S^a** **Rev. 01**

TYPE OF MATERIAL: *Ferritic -Austenitic Stainless Steel, Type 25Cr duplex*

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|----------------------------------|-----------------------|--------------|-------------------------|---|
| Bolting (strain hardened) | ASTM A1082 (modified) | UNS S32550 | - | ASTM A1082 S5 or S6 (nuts only), ASTM A962 S66 |
| | ASTM A1082 (modified) | UNS S32760 | - | ASTM A1082 S5 or S6 (nuts only), ASTM A962 S66 |

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Non-Destructive Testing All products shall be 100 % visually examined in all areas of threads, shanks, and heads. Discontinuities shall comply with requirements specified in ASTM F788 for bolts/studs and ASTM F812 for nuts.

Repair of Defects Weld repair is not permitted.

Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^a Material covered by this MDS is not referenced in ISO 15156 /NACE MR0175 nor ISO 17945 /NACE MR0103.
 NOTE Use of this material in sour service shall require separate qualification according to ISO 15156-3 /NACE MR0175-3 or ISO 17945/ NACE MR0103, as applicable.
 The material shall be traceable in accordance with ISO 15156-3 /NACE MR0175-3 section 7.2 and this MDS. The inspection documents required in this MDS shall also include the qualification test reports.

Dimensional Tolerances The maximum size of studs/bolts shall be M50 (2 in).

Marking ASTM A962 S66 shall apply.

Certification The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser.
 The inspection documents shall be issued in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification.
 The inspection documents shall include the following information:
 - The MPS identification or the MCPR/QTR number used (for bar and/or bolting as appropriate);
 - Bar manufacturer;
 - Heat treatment condition including solution annealing temperature, holding time and quenching medium for pre-material shall be stated.

^a The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

Material Data Sheet **MDS No. ID260 / ID260S^a** **Rev. 01**

TYPE OF MATERIAL: *Ferritic-Austenitic Stainless Steel, Type 25Cr duplex*

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|-----------------------------|------------|------------|------------------|--|
| Bolting (solution annealed) | ASTM A1082 | UNS S32550 | -- | ASTM A1082 S5 or S6 (nuts only), ASTM A962 S66 |
| | ASTM A1082 | UNS S32750 | -- | ASTM A1082 S5 or S6 (nuts only), ASTM A962 S66 |
| | ASTM A1082 | UNS S32760 | -- | ASTM A1082 S5 or S6 (nuts only), ASTM A962 S66 |

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| Scope | This MDS defines applicable options and/or requirements that supplement or amend the referenced ASTM standard specification. |
| Qualification | Manufacturers and the manufacturing process for bars as pre-material for bolting to this MDS shall be qualified in accordance with ISO 17782 or NORSOK M-650. The qualification testing shall meet the requirements of this MDS. Manufacturers and the manufacturing process for production of bolting that involves any further hot/cold working (except for cold rolling of threads) and/or heat treatment of bar pre-material shall be separately qualified in accordance with ISO 17782 or NORSOK M-650 and this MDS. |
| Metal Making | The melt shall be refined by AOD or equivalent method. |
| Manufacturing | Threads on studs and bolts may be made by cold rolling or machining. Threads in nuts shall be machined. |
| Chemical Composition | PREN ≥ 40.0 |
| Impact Testing/ Toughness testing | Impact testing of bolting shall be carried out in accordance with the requirements in ASTM A962 on a sample representing the finished bolting. Charpy V-notch tests shall be carried out at -46 °C (-50 °F) and the acceptance criteria shall be 45 J (33 ft lbf) average of three specimens, 35 J (26 ft lbf) minimum single specimen. |
| Proof Load Testing | A1082 S5 shall apply to at least one nut per test lot - the load shall comply with A194 Grade 7M. Alternatively, A1082 S6 may be applied as alternative to proof load testing for nuts with size M36 (1 ½ in) or above; the hardness shall not exceed the values specified in ASTM A1082 for the specified grades. |
| Corrosion testing | Testing shall be carried out on a sample representing the finished bolting. The sampling of test specimens, testing methodology and acceptance criteria shall be in accordance with the principles in ISO 17781. |
| Micrographic Examination | Testing shall be carried out on a sample representing the finished bolting. The sampling of test specimens, testing methodology and acceptance criteria for microstructural examination including ferrite measurements shall be in accordance with the principles in ISO 17781. |
| Extent of Testing | One tensile, one set of impact tests and corrosion test, and one micrographic examination including ferrite measurement shall be carried out for each test lot where a test lot is as-defined in ASTM A962 for non-heat treated, strain hardened bolting including the same lot for the bar material. |
| Non-Destructive Testing | All products shall be 100 % visually examined in all areas of threads, shanks, and heads. Discontinuities shall comply with requirements specified in ASTM F788 for bolts/studs and ASTM F812 for nuts. |
| Repair of Defects | Weld repair is not permitted. |

Material Data Sheet**MDS No. ID260 / ID260S^a****Rev. 01**

TYPE OF MATERIAL: Ferritic-Austenitic Stainless Steel, Type 25Cr duplex

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|-----------------------------|------------|------------|------------------|--|
| Bolting (solution annealed) | ASTM A1082 | UNS S32550 | -- | ASTM A1082 S5 or S6 (nuts only), ASTM A962 S66 |
| | ASTM A1082 | UNS S32750 | -- | ASTM A1082 S5 or S6 (nuts only), ASTM A962 S66 |
| | ASTM A1082 | UNS S32760 | -- | ASTM A1082 S5 or S6 (nuts only), ASTM A962 S66 |

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| Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^a | <p>When sour service requirements are specified by the purchaser, the material shall conform to the requirements of ISO 15156 /NACE MR0175 or ISO 17945 /NACE MR0103, and the following additional requirements to the MDS:</p> <p><u>Hardness testing</u></p> <p>Production hardness testing shall be performed in accordance with the requirements in ASTM A1082. Hardness may be measured at bar outer surface before threading or in area not affected by the thread rolling operation. The maximum hardness for UNS S32750 and UNS S32760 shall be 32HRC from three readings taken in close proximity. The maximum hardness for grade UNS S32550 shall not exceed 31HRC.</p> <p>The material shall be traceable in accordance with ISO 15156-3 /NACE MR0175-3 section 7.2 and this MDS.</p> |
| Marking | ASTM A962 S66 shall apply. |
| Certification | <p>The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser.</p> <p>The inspection documents shall be issued in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification.</p> <p>The inspection documents shall include the following information:</p> <ul style="list-style-type: none"> - The MPS identification or the MCPR/QTR number used (for bar and/or bolting as appropriate); - Bar manufacturer; - Solution annealing temperature, holding time and quenching medium shall be stated. |

^a The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

Material Data Sheet **MDS No. ID269 / ID269S^a** **Rev. 01**

TYPE OF MATERIAL: *Ferritic-Austenitic stainless steel type 25Cr duplex*

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|---------------------|-----------------|--------------|-------------------------|----------------------------------|
| HIP products | ASTM A988 | UNS S32750 | | ASTM A988 S5 |
| | ASTM A988 | UNS S32760 | | ASTM A988 S5 |
| | ASTM A988 | UNS S32505 | | ASTM A988 S5 |

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| Scope | <p>This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification.</p> <p>Product covered by this MDS is limited to a maximum thickness of 200 mm (8 in). For thickness exceeding 200 mm (8 in), qualification and specification requirements shall be subject to agreement.</p> | | | | | | | | | | |
|--|---|------------------------|--------------------------------|------------------------|------|--------|-----------------------------|---------------------|-------|---------------------|---|
| Qualification | Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or NORSOK M-650. The qualification testing shall meet the requirements of this MDS. | | | | | | | | | | |
| Metal Making | Gas atomized powder made from AOD-refined metal. Powder blends shall be a homogenous mixture of powder heats in terms of composition, particle size and other properties. | | | | | | | | | | |
| Chemical Composition | PREN ≥ 40.0 | | | | | | | | | | |
| Heat Treatment | <p>The HIP product shall be solution annealed followed by water/liquid quenching.</p> <p>Products shall be placed in such a way as to ensure free circulation of heating and cooling media around each fitting during the heat treatment process including quenching.</p> | | | | | | | | | | |
| Impact Testing/ Toughness testing | The sampling of test specimens, testing methodology and the acceptance criteria shall comply with ISO 17781 QL II. | | | | | | | | | | |
| Corrosion testing | The sampling of test specimens, testing methodology and acceptance criteria shall be in accordance with ISO 17781 for HIP product with weld ends. Test specimens shall be taken from the surface and the centre of the product with no weld ends. | | | | | | | | | | |
| Micrographic Examination | The sampling of test specimens, testing methodology and acceptance criteria for microstructural examination including ferrite measurements shall be in accordance with ISO 17781 for HIP product with weld ends. Test specimens shall be taken from the surface and the centre of the product with no weld ends and shall sample an area of 10 mm (0.4 in) by 10 mm (0.4 in) minimum. | | | | | | | | | | |
| Extent of Testing | One tensile, one set of impact tests and corrosion test, and one microstructure examination including ferrite measurement shall be carried out for each lot. A lot shall include all products from a single powder blend, same manufacturing procedure and same heat treatment load. | | | | | | | | | | |
| Non-Destructive Testing | <p><u>Visual inspection</u></p> <p>VT shall be carried out on each item in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be pickled prior to the testing.</p> <p><u>Liquid penetrant testing</u></p> <p>ASTM A988 supplementary requirement S5 shall apply as amended by this MDS:</p> <table border="1"> <thead> <tr> <th>NDE Requirement</th> <th>HIP product^a</th> </tr> </thead> <tbody> <tr> <td>Frequency^b</td> <td>10 %</td> </tr> <tr> <td>Method</td> <td>ASME BPVC Sec. V, Article 6</td> </tr> <tr> <td>Extent^c</td> <td>100 %</td> </tr> <tr> <td>Acceptance criteria</td> <td>ASME BPVC Sec. VIII, Div. 1, Appendix 8</td> </tr> </tbody> </table> <p>NOTE The testing shall be carried out after machining, if applicable. Non-machined surfaces shall be pickled prior to the testing.</p> <p>^a Parts of size DN > 50 (NPS > 2).</p> <p>^b For random examination (10 %), a minimum of one item per lot in any purchase order shall be examined. The test lot shall be as defined for mechanical testing.</p> <p>^c All accessible internal and external surfaces shall be examined.</p> | NDE Requirement | HIP product^a | Frequency ^b | 10 % | Method | ASME BPVC Sec. V, Article 6 | Extent ^c | 100 % | Acceptance criteria | ASME BPVC Sec. VIII, Div. 1, Appendix 8 |
| NDE Requirement | HIP product^a | | | | | | | | | | |
| Frequency ^b | 10 % | | | | | | | | | | |
| Method | ASME BPVC Sec. V, Article 6 | | | | | | | | | | |
| Extent ^c | 100 % | | | | | | | | | | |
| Acceptance criteria | ASME BPVC Sec. VIII, Div. 1, Appendix 8 | | | | | | | | | | |

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| Material Data Sheet | MDS No. ID269 / ID269S^a | Rev. 01 |
|----------------------------|---|----------------|

TYPE OF MATERIAL: Ferritic-Austenitic stainless steel type 25Cr duplex

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|---------------------|-----------------|--------------|-------------------------|----------------------------------|
| HIP products | ASTM A988 | UNS S32750 | | ASTM A988 S5 |
| | ASTM A988 | UNS S32760 | | ASTM A988 S5 |
| | ASTM A988 | UNS S32505 | | ASTM A988 S5 |

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| Repair of Defects | Weld repair is not permitted. |
| Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^a | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of ISO 15156 /NACE MR0175 or ISO 17945 /NACE MR0103, and this MDS: |
| | <u>Hardness testing</u> Production hardness testing shall be performed in accordance with the requirements in ASTM A370/A1058 on two parts per lot. When only one part is produced, it shall be hardness tested as required. The maximum hardness shall be 32HRC from three readings taken in close proximity. |
| | The material shall be traceable in accordance with ISO 15156-3 /NACE MR0175-3 section 7.2 and this MDS. |
| Surface Treatment and Finish | Finished components shall be pickled. Machined surfaces do not require pickling. |
| Marking | The powder blend shall have a unique identity marked on the powder container and this identity shall be recorded and maintained throughout production of the product. The components shall be marked to ensure full traceability to lot as defined in this MDS. |
| Certification | <p>The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser.</p> <p>The inspection documents shall be in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification.</p> <p>The inspection documents shall include the following information:</p> <ul style="list-style-type: none"> - MPS identification or MCPR/QTR number used; - Steel manufacturer of the starting material (powder) for the finished product; - Solution annealing temperature, holding time and quench medium shall be stated. |
| ^a The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service. | |

Material Data Sheet **MDS No. IK101** **Rev. 01**

TYPE OF MATERIAL: *Copper-Nickel 90-10*

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|--------------------------|-----------------|--------------|-------------------------|----------------------------------|
| Seamless pipes and tubes | ASTM B466 | UNS C70600 | - | - |

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| Scope | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. |
| Design and Dimensional Standards | The EEMUA standard No. 234: "Copper Nickel alloy piping for offshore applications specification" shall apply. |
| Manufacturing | Cold forming or hot forming may be used according to written procedures established in cooperation with the material manufacturers. |
| Chemical Composition | Zn ≤ 0.50 %, Pb ≤ 0.02 %, C ≤ 0.05 % |
| Heat Treatment | Hot formed pipe and tube: products hot formed in the temperature range of 760 °C (1 400 °F) to 800 °C (1 472 °F) do not need annealing after forming. Cold formed pipe and tube: annealed. |
| Tensile Testing | Tensile test specimens shall be taken from each lot where a lot is defined as all products of the same type and nominal size, which are produced from the same heat of material and subject to the same finishing operation. |
| Extent of Testing | Each length of finished pipe shall be subjected to a hydrostatic test. |
| Test Sampling | Test samples may be cut from the products themselves, from prolongations or from sacrificial pipe and tube. |
| Repair of Defects | Weld repair is not permitted. |
| Sour Service (additional metallurgical, manufacturing, testing and certification requirements) | There are no additional requirements to the MDS when sour service is specified by the purchaser. |
| Hydrostatic Tests | Each length of finished pipe shall be subjected to a hydrostatic test. |
| Certification | The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser. The inspection documents shall be in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification. |

| Material Data Sheet | | MDS No. IK102 | | Rev. 01 |
|---|---|---------------|------------------|---------------------------|
| TYPE OF MATERIAL: Copper-Nickel 90-10 | | | | |
| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
| Welded pipes | ASTM B467 | UNS C70600 | | |
| Page 1 of 1 | | | | |
| Scope | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| Design and Dimensional Standards | The EEMUA standard No. 234: "Copper Nickel alloy piping for offshore applications specification" shall apply. | | | |
| Chemical Composition | Zn ≤ 0.50 %, Pb ≤ 0.02 %; C ≤ 0.05 % | | | |
| Forming | Cold forming or hot forming may be used according to written procedures established in cooperation with the material manufacturers. | | | |
| Welding | An electric fusion welding process shall be used. Welding procedures shall be established and qualified in accordance with ASME BPVC Sec. IX. | | | |
| Heat Treatment | Hot formed pipes: pipes hot formed in the temperature range of 760 °C (1 400 °F) to 800 °C (1 472 °F) do not need annealing after forming. Cold formed pipes: annealed. Welded pipes: annealed or as-welded from annealed materials. | | | |
| Tensile Testing | Tensile test specimens shall be taken from each lot where a lot is defined as all products of the same type and nominal size, which are produced from the same heat of material and subject to the same finishing operation. | | | |
| Test Sampling | Test samples may be cut from the products themselves, from prolongations or from sacrificial pipes. | | | |
| Non-Destructive Testing | <u>Radiographic testing</u> – SCH 10S: Welded pipes shall be spot radiographed to the extent of not less than 300 mm (12 in) per 15 m (49 ft) of weld; – Other schedules: All welds shall be 100 % radiographed. The radiographic testing shall be in accordance with the requirements of the ASME BPVC Sec. VIII, Div. 1, Paragraph UW-51 and UW-52 for 100 % and spot radiography, respectively. | | | |
| Repair of Defects | Weld repair of base material is not permitted. For repair of welds, the requirements for production welding shall apply to the repair WPS. | | | |
| Sour Service (additional metallurgical, manufacturing, testing and certification requirements) | There are no additional requirements to the MDS when sour service is specified by the purchaser. | | | |
| Hydrostatic Tests | Each length of finished pipe shall be subjected to a hydrostatic test | | | |
| Certification | The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser. The inspection documents shall be in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification. | | | |

| Material Data Sheet | | MDS No. IK103 | | Rev. 01 |
|---|--|---------------|-------------------------|----------------------------------|
| TYPE OF MATERIAL: Copper-Nickel 90-10 | | | | |
| <i>PRODUCT FORM</i> | <i>STANDARD</i> | <i>GRADE</i> | <i>ACCEPTANCE CLASS</i> | <i>SUPPLEMENTARY REQUIREMENT</i> |
| Fittings | EEMUA 234 | UNS C76000 | - | - |
| Page 1 of 1 | | | | |
| Scope | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| Design and Dimensional Standards | The EEMUA standard No. 234: "Copper Nickel alloy piping for offshore applications specification" shall apply. | | | |
| Manufacturing | Cold forming or hot forming may be used according to written procedures established in cooperation with the material manufacturers. | | | |
| Chemical Composition | For fittings subject to welding, the chemical composition shall be modified as follows: Zn ≤ 0.50 %, Pb ≤ 0.02 %, C ≤ 0.05 % | | | |
| Welding | An electric fusion welding process shall be used. Welding procedures shall be established and qualified in accordance with ASME BPVC Sec. IX. | | | |
| Heat Treatment | Hot formed fittings: fittings hot formed in the temperature range of 760 °C (1 400 °F) to 800 °C (1 472 °F) do not need annealing after forming. Cold formed fittings: annealed. Welded fittings: annealed or as-welded from annealed materials. | | | |
| Tensile Testing | Tensile test specimens shall be taken from each lot where a lot is defined as all products of the same type and nominal size, which are produced from the same heat of material and subject to the same finishing operation. | | | |
| Test Sampling | Test samples may be cut from the products themselves, from prolongations or from sacrificial fittings. | | | |
| Repair of Defects | Weld repair of base material is not permitted. For repair of welds, the requirements for production welding shall apply to the repair WPS. | | | |
| Sour Service (additional metallurgical, manufacturing, testing and certification requirements) | There are no additional requirements to the MDS when sour service is specified by the purchaser. | | | |
| Certification | The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser. The inspection documents shall be in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification. | | | |

| Material Data Sheet | | MDS No. IK104 | | Rev. 01 |
|---|--|---------------|-------------------------|----------------------------------|
| TYPE OF MATERIAL: Copper-Nickel 90-10 | | | | |
| <i>PRODUCT FORM</i> | <i>STANDARD</i> | <i>GRADE</i> | <i>ACCEPTANCE CLASS</i> | <i>SUPPLEMENTARY REQUIREMENT</i> |
| Flanges | EEMUA 234 | UNS C76000 | | |
| Page 1 of 1 | | | | |
| Scope | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| Design and Dimensional Standards | The EEMUA standard No. 234: "Copper Nickel alloy piping for offshore applications specification" shall apply. | | | |
| Manufacturing | Cold forming or hot forming may be used according to written procedures established in cooperation with the material manufacturers. | | | |
| Chemical Composition | For flanges subject to welding, the chemical composition shall be modified as follows: Zn ≤ 0.50 %, Pb ≤ 0.02 %, C ≤ 0.05 % | | | |
| Heat Treatment | Hot formed flanges: flanges hot formed in the temperature range of 760 °C (1 400 °F) to 800 °C (1 472 °F) do not need annealing after forming. Cold formed flanges: annealed. | | | |
| Tensile Testing | Tensile test specimens shall be taken from each lot where a lot is defined as all products of the same type and nominal size, which are produced from the same heat of material and subject to the same finishing operation. | | | |
| Test Sampling | Test samples may be cut from the products themselves, from prolongations or from sacrificial flanges. | | | |
| Repair of Defects | Weld repair is not permitted. | | | |
| Sour Service (additional metallurgical, manufacturing, testing and certification requirements) | There are no additional requirements to the MDS when sour service is specified by the purchaser. | | | |
| Certification | The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser. The inspection documents shall be in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification. | | | |

| | | |
|----------------------------|----------------------|----------------|
| Material Data Sheet | MDS No. IK105 | Rev. 01 |
|----------------------------|----------------------|----------------|

| TYPE OF MATERIAL: Copper-Nickel 90-10 | | | | |
|---|--|--------------|-------------------------|----------------------------------|
| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
| Plates | ASTM B171 | UNS C70600 | | |
| Page 1 of 1 | | | | |
| Scope | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| Design and Dimensional Standards | The EEMUA standard No. 234: "Copper Nickel alloy piping for offshore applications specification" shall apply. | | | |
| Manufacturing | Cold forming or hot forming may be used according to written procedures established in cooperation with the material manufacturers. | | | |
| Chemical Composition | For plates subject to welding, the chemical composition shall be modified as follows: Zn ≤ 0.50 %, Pb ≤ 0.02 %, C ≤ 0.05 % | | | |
| Heat Treatment | Plate shall be annealed. Hot rolled/forged plate in the temperature range of 760 °C (1 400 °F) to 800 °C (1 472 °F) do not need annealing after forming. | | | |
| Tensile Testing | Tensile test specimens shall be taken from each lot where a lot is defined as all products of the same type and nominal size, which are produced from the same heat of material and subject to the same finishing operation. | | | |
| Test Sampling | Test samples may be cut from the products themselves, from prolongations or from sacrificial plates. | | | |
| Repair of Defects | Weld repair is not permitted. | | | |
| Sour Service (additional metallurgical, manufacturing, testing and certification requirements) | There are no additional requirements to the MDS when sour service is specified by the purchaser. | | | |
| Certification | The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser. The inspection documents shall be in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification. | | | |

Material Data Sheet **MDS No. IK106** **Rev. 01**

TYPE OF MATERIAL: Aluminium bronze

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|--------------|-----------|------------|------------------|---------------------------|
| Castings | ASTM B148 | UNS C95800 | | |

Page 1 of 2

Scope This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification.

Heat Treatment Heat treatment may be carried out at the discretion of the manufacturer.

Extent of Testing One tensile test shall be carried out for each lot as defined by the in ASTM B148.

Non-Destructive Testing

Visual inspection
 VT shall be carried out on each casting in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be pickled prior to the testing.

Liquid penetrant testing

| NDE Requirement | Pilot casting (section 4.8) | Production casting ^a |
|------------------------|---|---|
| Frequency ^b | 100 % | 100 % |
| Method | ASME BPVC Sec. V, Article 6 | ASME BPVC Sec. V, Article 6 |
| Extent ^c | 100 % | 100 % |
| Acceptance criteria | ASME BPVC Sec. VIII, Div. 1, Appendix 7 | ASME BPVC Sec. VIII, Div. 1, Appendix 7 |

NOTE The testing shall be carried out after machining, if applicable. Non-machined surfaces shall be pickled prior to the testing.

^a Production valve castings, PT shall be according to the applicable valve specification. If a QSL is not specified by the purchaser, the requirements in this table shall apply.

^b Frequency of inspection 100 % means that each item shall be examined.

^c All accessible internal and external surfaces shall be examined.

Radiographic testing

| NDE requirement | Pilot casting (section 4.8) | Production casting | | | | Other pressure containing castings ^b |
|------------------------|-----------------------------|--|-------|----------------|-----|---|
| | | Valve castings ^a | | | | |
| Frequency ^c | 100 % | NPS | DN | Pressure class | | 100 % |
| | | | | ≤ 150 | 300 | |
| | | < 10 | < 250 | N/R | N/R | |
| | | ≥ 10 | ≥ 250 | 5 % | 5 % | |
| Method | | ASME BPVC Sec. V, Article 2 | | | | |
| Extent | | Areas defined by ASME B16.34 for special class valves, at abrupt changes in sections and at the junctions of risers, gates or feeders to the casting | | | | 100 % ^d |
| Acceptance criteria | | ASME BPVC Sec. VIII, Div. 1, Appendix 7 | | | | |

NOTE N/R means not required, unless specified otherwise by the purchaser.

- ^a Production valve casting, RT shall be according to the applicable valve specification. If a QSL is not specified by the purchaser, the requirements in this table shall apply.
- ^b Production casting other than valve casting.
- ^c Frequency of inspection 100 % means that each item shall be examined. When random examination (5 %) is specified, a minimum of one item per lot of each pattern in any purchase order shall be examined.
- ^d Production casting other than valve casting, inspection shall include other critical areas as defined in the purchase order and/or applicable product specification or standard. Sketches of the areas to be tested shall be established and agreed with the purchaser.

| | | |
|----------------------------|----------------------|----------------|
| Material Data Sheet | MDS No. IK106 | Rev. 01 |
|----------------------------|----------------------|----------------|

TYPE OF MATERIAL: *Aluminium bronze*

| <i>PRODUCT FORM</i> | <i>STANDARD</i> | <i>GRADE</i> | <i>ACCEPTANCE CLASS</i> | <i>SUPPLEMENTARY REQUIREMENT</i> |
|---------------------|-----------------|--------------|-------------------------|----------------------------------|
| Castings | ASTM B148 | UNS C95800 | | |

Page 2 of 2

| | |
|---|--|
| Repair of Defects | <p>Repairs that exceed those described in ASTM B148 section 10.1 shall be considered major repairs. All major repairs shall be documented with a sketch showing location and size of excavations. Weld repairs are not acceptable for castings that leak during the final pressure testing. Repairs by peening and impregnation are prohibited. The repair welding procedure shall be qualified in accordance with ASME BPVC Sec. IX; a change of filler metal brand names requires requalification.</p> |
| Sour Service (additional metallurgical, manufacturing, testing and certification requirements) | <p>There are no additional requirements to the MDS when sour service is specified by the purchaser.</p> |
| Certification | <p>The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser. The inspection documents shall be in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification. The inspection documents shall include the following information:</p> <ul style="list-style-type: none"> - Heat treatment condition (annealing temperature). |

| Material Data Sheet | | | | | MDS No. IK107 | | Rev. 01 | |
|---|--|------------|------------------|---------------------------|---------------|--|---------|--|
| TYPE OF MATERIAL: <i>Copper-Nickel 90-10</i> | | | | | | | | |
| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT | | | | |
| Rods and bars | ASTM B151 | UNS C70600 | | | | | | |
| Page 1 of 1 | | | | | | | | |
| Scope | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | | | | | |
| Design and Dimensional Standards | The EEMUA standard No. 234: "Copper Nickel alloy piping for offshore applications specification" shall apply. | | | | | | | |
| Manufacturing | Cold forming or hot forming may be used according to written procedures established in cooperation with the material manufacturers. | | | | | | | |
| Heat Treatment | Rods and bars hot formed in the temperature range of 760 °C (1 400 °F) to 800 °C (1 472 °F) do not need annealing after forming. Cold formed rods and bars: annealed. | | | | | | | |
| Tensile Testing | Tensile test specimens shall be taken from each lot where a lot is defined as all products of the same type and nominal size, which are produced from the same heat of material and subject to the same finishing operation. | | | | | | | |
| Test Sampling | Test samples may be cut from the products themselves, from prolongations or from sacrificial rods and bars. | | | | | | | |
| Repair of Defects | Weld repair is not permitted. | | | | | | | |
| Sour Service (additional metallurgical, manufacturing, testing and certification requirements) | There are no additional requirements to the MDS when sour service is specified by the purchaser. | | | | | | | |
| Certification | The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser. The inspection documents shall be in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification. | | | | | | | |

Material Data Sheet **MDS No. IN100S^a** **Rev. 01**

TYPE OF MATERIAL: Nickel alloy type 625

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|---------------------|-----------------|--------------|-------------------------|----------------------------------|
| Bolting | ASTM F468 | UNS N06625 | -- | -- |
| | ASTM F467 | UNS N06625 | Grade 2 | -- |

Page 1 of 1

| | |
|---|---|
| Scope | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. |
| Metal Making | Basic electric furnace (EF) melt shall be refined by AOD or VOD followed by electro slag remelting (ESR) or vacuum arc remelting (VAR) or equivalent multiple refining methods. In alternative, vacuum induction melting (VIM) can be followed by single refining method such as ESR or VAR. |
| Manufacturing | Threading of studs, bolts and screws may be done by machining or rolling. Thread rolling shall be done after heat treatment. Threads in nuts shall be machined. |
| Tensile Testing | For sizes above 37.5 mm (1½ in) in diameter the strength properties shall be agreed. |
| Non-Destructive Testing | All products shall be 100 % visually examined in all areas of threads, shanks and heads. Discontinuities shall comply with requirements specified in ASTM F788 for bolts/studs and ASTM F812 for nuts. |
| Repair of Defects | Weld repair is not permitted. |
| Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^a | The material shall conform to the requirements of ISO 15156/ NACE MR0175 or ISO 17945 /NACE MR0103 and this MDS. The material shall be traceable in accordance with ISO 15156-3 /NACE MR0175-3 section 7.2 and this MDS. |
| Marking | Each bolt and nut shall be marked on the end/head to ensure full traceability to heat and heat treatment lot. |
| Certification | The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser. The inspection documents shall be in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification. The inspection documents shall include the following information: - Heat treatment conditions (annealing temperature and time shall be stated); - Original inspection documents of the bar material shall be included in the documentation. |

^a The supplementary suffix "S" designates a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| Material Data Sheet | | MDS No. IN102S ^a | | Rev. 01 |
|--|---|-----------------------------|-------------------------|----------------------------------|
| TYPE OF MATERIAL: Nickel alloy type 625 | | | | |
| <i>PRODUCT FORM</i> | <i>STANDARD</i> | <i>GRADE</i> | <i>ACCEPTANCE CLASS</i> | <i>SUPPLEMENTARY REQUIREMENT</i> |
| Welded pipes | ASTM B705 | UNS N06625 Grade 1 | Class 2 | |
| Page 1 of 1 | | | | |
| Scope | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| Metal Making | Basic electric furnace (EF) melt shall be refined by AOD or VOD followed by electro slag remelting (ESR) or vacuum arc remelting (VAR) or equivalent multiple refining methods. In alternative, vacuum induction melting (VIM) can be followed by single refining method such as ESR or VAR. | | | |
| Welding | Welding procedures shall be qualified in accordance with ASME BPVC Sec. IX or ISO 15614-1 using the same material grade (UNS number) as used in production. | | | |
| Heat Treatment | Pipes shall be placed in such a way as to ensure free circulation of heating and cooling media around each pipe during the heat treatment process including any rapid cooling/quenching | | | |
| Extent of Testing | A lot shall consist of all pipes of the same type, size and wall thickness, manufactured from one heat of material, and using the same classification of welding product. | | | |
| Repair of Defects | Weld repair of base material is not permitted. For repair of welds, the requirements for production welding shall apply to the repair WPS. | | | |
| Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^a | The material shall conform to the requirements of ISO 15156 /NACE MR0175 or ISO 17945 /NACE MR0103, and this MDS. | | | |
| | The material shall be traceable in accordance with ISO 15156-3 /NACE MR0175-3 section 7.2 and this MDS. | | | |
| Surface Treatment and Finish | Finished pipes shall be pickled. | | | |
| Marking | The pipe shall be marked to ensure full traceability to heat and heat treatment lot. | | | |
| Certification | <p>The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser.</p> <p>The inspection documents shall be issued in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification.</p> <p>The inspection documents shall include the following information:</p> <ul style="list-style-type: none"> - Heat treatment condition (annealing temperature shall be stated). | | | |
| <p>^a The supplementary suffix "S" designates a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.</p> | | | | |

| Material Data Sheet | | | | |
|---|---|--------------------|-------------------------------|---------------------------|
| MDS No. IN103S ^a | | | Rev. 01 | |
| TYPE OF MATERIAL: Nickel alloy type 625 | | | | |
| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
| Wrought fittings | ASTM B366 | UNS N06625 Grade 1 | WP Cl. S, WP Cl. W, WP Cl. WX | ASTM B366 S3 |
| Page 1 of 1 | | | | |
| Scope | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| Metal Making | Basic electric furnace (EF) melt shall be refined by AOD or VOD followed by electro slag remelting (ESR) or vacuum arc remelting (VAR) or equivalent multiple refining methods. In alternative, vacuum induction melting (VIM) can be followed by single refining method such as ESR or VAR. | | | |
| Welding | Welding procedures shall be qualified in accordance with ASME BPVC Sec. IX or ISO 15614-1 using the same material grade (UNS number) as used in production. A change of filler metal classification requires requalification. | | | |
| Heat Treatment | fittings shall be placed in such a way as to ensure free circulation of heating and cooling media around each fitting during the heat treatment process including any rapid cooling/quenching. | | | |
| Extent of Testing | A lot shall consist of all fittings of the same type, size, and wall thickness, manufactured from one heat of material, and, if welding is performed, using the same classification of welding product. | | | |
| Non-Destructive Testing | S3 shall apply to the weld end area of 10 % of seamless fittings from each lot and 100 % of welded fittings above NPS2. For welded fittings, the testing shall cover the weld only. | | | |
| Repair of Defects | Weld repair of base material is not permitted. For repair of welds, the requirements for production welding shall apply to the repair WPS. | | | |
| Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^a | The material shall conform to the requirements of ISO 15156 /NACE MR0175 or ISO 17945 /NACE MR0103, and this MDS. | | | |
| | The material shall be traceable in accordance with ISO 15156-3 /NACE MR0175-3 section 7.2 and this MDS. | | | |
| Surface Treatment and Finish | Finished fittings shall be pickled. Machined surfaces do not require pickling. | | | |
| Marking | The fittings shall be marked to ensure full traceability to heat and heat treatment lot. | | | |
| Certification | The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser. The inspection documents shall be issued in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification. The inspection documents shall include the following information: - Heat treatment condition (annealing temperature shall be stated). | | | |
| ^a The supplementary suffix "S" designates a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service. | | | | |

| Material Data Sheet | | MDS No. IN104S ^a | | Rev. 01 | | | | | | | | | | |
|---|--|-----------------------------|-------------------------|----------------------------------|-----------------|----------|------------------------|------|--------|-----------------------------|---------------------|-------|---------------------|---|
| TYPE OF MATERIAL: Nickel alloy type 625 | | | | | | | | | | | | | | |
| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT | | | | | | | | | | |
| Forgings | ASTM B564 | UNS N06625 | | ASTM B564 S5.3 | | | | | | | | | | |
| Page 1 of 2 | | | | | | | | | | | | | | |
| Scope | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | | | | | | | | | | | |
| Metal Making | Basic electric furnace (EF) melt shall be refined by AOD or VOD followed by electro slag remelting (ESR) or vacuum arc remelting (VAR) or equivalent multiple refining methods. In alternative, vacuum induction melting (VIM) can be followed by single refining method such as ESR or VAR. | | | | | | | | | | | | | |
| Heat Treatment | Forgings shall be placed in such a way as to ensure free circulation of heating and cooling media around each component during the heat treatment process including any rapid cooling/quenching. | | | | | | | | | | | | | |
| Extent of Testing | A lot shall consist of all forgings of the same type, size, and wall thickness, manufactured from one heat of material. | | | | | | | | | | | | | |
| Non-Destructive Testing | <p><u>Visual Inspection</u></p> <p>VT shall be carried out on each forging or bar in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be pickled prior to the testing.</p> <p><u>Liquid penetrant testing</u></p> <p>ASTM B564 Supplementary requirement S5.3 shall apply as amended by this MDS:</p> <table border="1" style="width: 100%;"> <thead> <tr> <th>NDE Requirement</th> <th>Forgings</th> </tr> </thead> <tbody> <tr> <td>Frequency^b</td> <td>10 %</td> </tr> <tr> <td>Method</td> <td>ASME BPVC Sec. V, Article 6</td> </tr> <tr> <td>Extent^c</td> <td>100 %</td> </tr> <tr> <td>Acceptance criteria</td> <td>ASME BPVC Sec. VIII, Div. 1, Appendix 8</td> </tr> </tbody> </table> <p>NOTE The testing shall be carried out after machining, if applicable. Non-machined surfaces shall be pickled prior to the testing.</p> <p>^a Parts of size DN > 50 (NPS > 2).</p> <p>^b For random examination (10 %), a minimum of one item per lot in any purchase order shall be examined. The test lot shall be as defined for mechanical testing.</p> <p>^c All accessible internal and external surfaces shall be examined.</p> | | | | NDE Requirement | Forgings | Frequency ^b | 10 % | Method | ASME BPVC Sec. V, Article 6 | Extent ^c | 100 % | Acceptance criteria | ASME BPVC Sec. VIII, Div. 1, Appendix 8 |
| | NDE Requirement | Forgings | | | | | | | | | | | | |
| Frequency ^b | 10 % | | | | | | | | | | | | | |
| Method | ASME BPVC Sec. V, Article 6 | | | | | | | | | | | | | |
| Extent ^c | 100 % | | | | | | | | | | | | | |
| Acceptance criteria | ASME BPVC Sec. VIII, Div. 1, Appendix 8 | | | | | | | | | | | | | |
| | <p><u>Valve forgings NDT</u></p> <p>Inspection shall be according to the applicable valve specification.</p> <p>If a QSL is not specified by the purchaser, the requirements in this MDS shall apply.</p> | | | | | | | | | | | | | |
| Repair of Defects | Weld repair is not permitted. | | | | | | | | | | | | | |
| Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^a | The material shall conform to the requirements of ISO 15156 /NACE MR0175 or ISO 17945 /NACE MR0103 and this MDS. | | | | | | | | | | | | | |
| | The material shall be traceable in accordance with ISO 15156-3 /NACE MR0175-3 section 7.2 and this MDS. | | | | | | | | | | | | | |
| Surface Treatment and Finish | Finished components shall be pickled. Machined surfaces do not require pickling. | | | | | | | | | | | | | |
| Marking | The component shall be marked to ensure full traceability to heat and heat treatment lot. | | | | | | | | | | | | | |

Material Data Sheet **MDS No. IN104S^a** **Rev. 01**

TYPE OF MATERIAL: Nickel alloy type 625

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|---------------------|-----------------|--------------|-------------------------|----------------------------------|
| Forgings | ASTM B564 | UNS N06625 | | ASTM B564 S5.3 |

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| | |
|----------------------|---|
| Certification | <p>The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser.</p> <p>The inspection documents shall be issued in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification.</p> <p>The inspection documents shall include the following information:</p> <ul style="list-style-type: none"> - Heat treatment condition (annealing temperature shall be stated). |
|----------------------|---|

^a The supplementary suffix "S" designates a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| Material Data Sheet | | | | |
|--|---|--------------------|-------------------------|----------------------------------|
| MDS No. IN105S ^a | | | Rev. 01 | |
| TYPE OF MATERIAL: <i>Nickel alloy type 625</i> | | | | |
| <i>PRODUCT FORM</i> | <i>STANDARD</i> | <i>GRADE</i> | <i>ACCEPTANCE CLASS</i> | <i>SUPPLEMENTARY REQUIREMENT</i> |
| Plates, sheets, strips | ASTM B443 | UNS N06625 Grade 1 | | |
| Page 1 of 1 | | | | |
| Scope | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| Metal Making | Basic electric furnace (EF) melt shall be refined by AOD or VOD followed by ESR (electro slag remelting) or VAR (vacuum arc remelting) or equivalent multiple refining methods. In alternative, vacuum induction melting (VIM) can be followed by single refining method such as ESR or VAR. | | | |
| Heat Treatment | Plates, sheets and strips shall be placed in such a way as to ensure free circulation of heating and cooling media around each product during the heat treatment process including any rapid cooling/quenching. | | | |
| Non-Destructive Testing | <u>Visual Inspection</u> VT shall be carried out on each plate in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be cleaned prior to the testing. | | | |
| | <u>Valve plate NDT</u> Inspection shall be according to the applicable valve specification. If a QSL is not specified by the purchaser, the requirements in this MDS shall apply. | | | |
| Repair of Defects | Weld repair is not permitted. | | | |
| Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^a | The material shall conform to the requirements of ISO 15156 /NACE MR0175 or ISO 17945 /NACE MR0103, and this MDS. | | | |
| | The material shall be traceable in accordance with ISO 15156-3 /NACE MR0175-3 section 7.2 and this MDS. | | | |
| Surface Treatment and Finish | Finished components shall be pickled. | | | |
| Marking | The plates, sheets and strips shall be marked to ensure full traceability to heat and heat treatment lot. | | | |
| Certification | <p>The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser.</p> <p>The inspection documents shall be issued in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification.</p> <p>The inspection documents shall include the following information:</p> <ul style="list-style-type: none"> - Heat treatment condition (annealing temperature shall be stated). | | | |
| <p>^a The supplementary suffix "S" designates a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.</p> | | | | |

Material Data Sheet **MDS No. IN106S^a** **Rev. 01**

TYPE OF MATERIAL: *Nickel alloy*

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|---------------------|-----------------|--------------------------|-------------------------|--|
| Castings | ASTM A494 | Grade CW6MC (UNS N26625) | | ASTM A494 S2, S3 ASTM A781 S16 ASTM A957 S16 |
| | ASTM A494 | Grade CX2MW (UNS N26022) | | ASTM A494 S2, S3 ASTM A781 S16 ASTM A957 S16 |

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Scope
This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification.
For castings produced by the investment casting process, the requirements of ASTM A957 and this MDS shall apply.

Qualification
Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or NORSOK M-650. The qualification testing shall meet the requirements of this MDS.

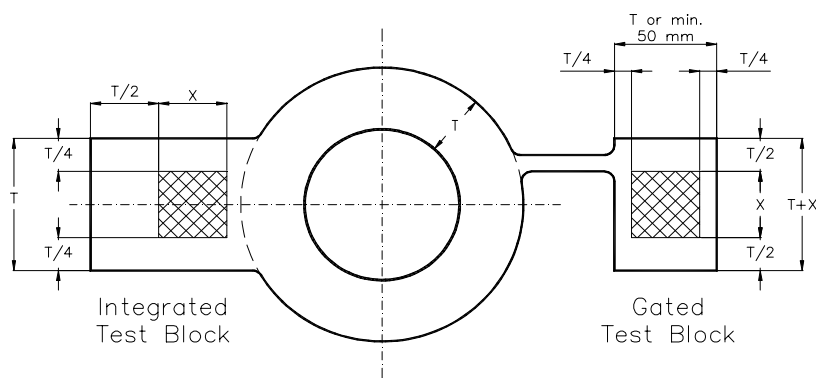
Metal Making
The melt shall be refined by AOD or equivalent method. Induction melting of AOD refined ingot is regarded to be equivalent to AOD refined materials.

Heat Treatment
Castings shall be placed in such a way as to ensure free circulation of heating and cooling media around each casting during the heat treatment process including quenching.

Corrosion testing
Corrosion test according to ASTM G 48 Method A is required. Test temperature shall be 50 °C (122 °F) and the exposure time 24 h. The corrosion test specimen shall be at the same location as those for mechanical testing. Cut edges shall be prepared according to ASTM G48. The complete specimen shall be pickled before being weighed and tested. Pickling may be performed for 5 min at 60 °C (140 °F) in a solution of 20 % HNO₃ + 5 % HF.
The acceptance criteria are:
- No pitting at 20x magnification;
- The weight loss shall be less than 4.0 g/m².

Extent of Testing
Tensile test and corrosion test shall be made for each heat and heat treatment load (including any PWHT). A test lot shall not exceed 5 000 kg (11 000 lb).

Test Sampling
Test blocks shall be integral or gated with the casting(s) they represent castings through all heat treatment operations.
Thickness of the test block shall be equal to the thickest part of the casting castings; the largest flange thickness is the ruling section.
Dimensions of test blocks and location of test specimens within the test blocks are shown in the figure below.
The test specimens shall be taken within the cross hatched area. Distance from end of test specimen to end of test block shall minimum be T/4.
During any PWHT the test block shall be tack welded onto the casting.



For investment casting, test sampling shall be according to A957. Test blocks shall accompany the castings through all heat treatment operations including any post weld stress relieving.

Material Data Sheet **MDS No. IN106S^a** **Rev. 01**

TYPE OF MATERIAL: *Nickel alloy*

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|--------------|-----------|--------------------------|------------------|--|
| Castings | ASTM A494 | Grade CW6MC (UNS N26625) | | ASTM A494 S2, S3 ASTM A781 S16 ASTM A957 S16 |
| | ASTM A494 | Grade CX2MW (UNS N26022) | | ASTM A494 S2, S3 ASTM A781 S16 ASTM A957 S16 |

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| Non-Destructive Testing | <p><u>Visual inspection</u></p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 25%;">NDE requirement</th> <th style="width: 35%;">Pilot casting (section 4.8)</th> <th style="width: 40%;">Production casting</th> </tr> </thead> <tbody> <tr> <td>Frequency</td> <td style="text-align: center;">Each pilot casting</td> <td style="text-align: center;">Each production casting</td> </tr> <tr> <td>Method</td> <td colspan="2" style="text-align: center;">ANSI/MSS SP-55</td> </tr> <tr> <td>Extent</td> <td colspan="2" style="text-align: center;">100 % of all accessible surfaces including welding ends</td> </tr> <tr> <td>Acceptance criteria</td> <td colspan="2" style="text-align: center;">MSS SP-55</td> </tr> </tbody> </table> <p>NOTE The testing shall be carried out after machining, if applicable. Non-machined surfaces shall be pickled prior to the testing.</p> <p><u>Liquid penetrant testing</u></p> <p>ASTM A494 Supplementary requirement S3 shall apply as amended by this MDS:</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 25%;">NDE Requirement</th> <th style="width: 35%;">Pilot casting (section 4.8)</th> <th style="width: 40%;">Production casting^a</th> </tr> </thead> <tbody> <tr> <td>Frequency^b</td> <td style="text-align: center;">100 %</td> <td style="text-align: center;">100 %</td> </tr> <tr> <td>Method</td> <td style="text-align: center;">ASME BPVC Sec. V, Article 6</td> <td style="text-align: center;">ASME BPVC Sec. V, Article 6</td> </tr> <tr> <td>Extent^c</td> <td style="text-align: center;">100 %</td> <td style="text-align: center;">100 %</td> </tr> <tr> <td>Acceptance criteria</td> <td style="text-align: center;">ASME BPVC Sec. VIII, Div. 1, Appendix 7</td> <td style="text-align: center;">ASME BPVC Sec. VIII, Div. 1, Appendix 7</td> </tr> </tbody> </table> <p>NOTE The testing shall be carried out after machining, if applicable. Non-machined surfaces shall be cleaned prior to the testing.</p> <p>^a Production valve castings, PT shall be according to the applicable valve specification. If a QSL is not specified by the purchaser, the requirements in this table shall apply.</p> <p>^b Frequency of inspection 100 % means that each item shall be examined.</p> <p>^c All accessible internal and external surfaces shall be examined.</p> | | | NDE requirement | Pilot casting (section 4.8) | Production casting | Frequency | Each pilot casting | Each production casting | Method | ANSI/MSS SP-55 | | Extent | 100 % of all accessible surfaces including welding ends | | Acceptance criteria | MSS SP-55 | | NDE Requirement | Pilot casting (section 4.8) | Production casting ^a | Frequency ^b | 100 % | 100 % | Method | ASME BPVC Sec. V, Article 6 | ASME BPVC Sec. V, Article 6 | Extent ^c | 100 % | 100 % | Acceptance criteria | ASME BPVC Sec. VIII, Div. 1, Appendix 7 | ASME BPVC Sec. VIII, Div. 1, Appendix 7 |
|--------------------------------|--|---|--|-----------------|-----------------------------|--------------------|-----------|--------------------|-------------------------|--------|----------------|--|--------|---|--|---------------------|-----------|--|-----------------|-----------------------------|---------------------------------|------------------------|-------|-------|--------|-----------------------------|-----------------------------|---------------------|-------|-------|---------------------|---|---|
| NDE requirement | Pilot casting (section 4.8) | Production casting | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Frequency | Each pilot casting | Each production casting | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Method | ANSI/MSS SP-55 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Extent | 100 % of all accessible surfaces including welding ends | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Acceptance criteria | MSS SP-55 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| NDE Requirement | Pilot casting (section 4.8) | Production casting ^a | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Frequency ^b | 100 % | 100 % | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Method | ASME BPVC Sec. V, Article 6 | ASME BPVC Sec. V, Article 6 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Extent ^c | 100 % | 100 % | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Acceptance criteria | ASME BPVC Sec. VIII, Div. 1, Appendix 7 | ASME BPVC Sec. VIII, Div. 1, Appendix 7 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Material Data Sheet **MDS No. IN106S^a** **Rev. 01**

TYPE OF MATERIAL: Nickel alloy

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|--------------|-----------|--------------------------|------------------|--|
| Castings | ASTM A494 | Grade CW6MC (UNS N26625) | | ASTM A494 S2, S3 ASTM A781 S16 ASTM A957 S16 |
| | ASTM A494 | Grade CX2MW (UNS N26022) | | ASTM A494 S2, S3 ASTM A781 S16 ASTM A957 S16 |

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Radiographic testing
ASTM A494 supplementary requirement S2 shall apply as amended by this MDS:

| NDE requirement | Pilot casting (section 4.8) | Production casting | | | | | | |
|------------------------|--|-----------------------------|-------|----------------|--------------------|---|-------|--------|
| | | Valve castings ^a | | | | Other pressure containing castings ^b | | |
| Frequency ^c | 100 % | NPS | DN | Pressure class | | | 100 % | |
| | | | | ≤ 300 | 600 | 900 | | ≥ 1500 |
| | | < 2 | < 50 | N/R | N/R | N/R | | N/R |
| | | ≥ 2 | ≥ 50 | N/R | 5 % | 5 % | | 5 % |
| | | ≥ 6 | ≥ 150 | N/R | 5 % | 5 % | | 100 % |
| | | ≥ 10 | ≥ 250 | 5 % | 5 % | 5 % | | 100 % |
| | | ≥ 16 | ≥ 400 | 5 % | 5 % | 100 % | | 100 % |
| ≥ 20 | ≥ 500 | 5 % | 100 % | 100 % | 100 % | | | |
| Method | ASME BPVC Sec. V, Article 2 | | | | | | | |
| Extent | Areas defined by ASME B16.34 for special class valves, at abrupt changes in sections and at the junctions of risers, gates or feeders to the casting | | | | 100 % ^d | | | |
| Acceptance criteria | ASME BPVC Sec. VIII, Div. 1, Appendix 7 | | | | | | | |

NOTE N/R means not required, unless specified otherwise by the purchaser.

^a Production valve casting, RT shall be according to the applicable valve specification. If a QSL is not specified by the purchaser, the requirements in this table shall apply.

^b Production casting other than valve casting.

^c Frequency of inspection 100 % means that each item shall be examined. When random examination (5 %) is specified, a minimum of one item per lot of each pattern in any purchase order shall be examined.

^d Production casting other than valve casting, inspection shall include other critical areas as defined in the purchase order and/or applicable product specification or standard. Sketches of the areas to be tested shall be established and agreed with the purchaser.

Material Data Sheet **MDS No. IN106S^a** **Rev. 01**

TYPE OF MATERIAL: *Nickel alloy*

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|---------------------|-----------------|--------------------------|-------------------------|--|
| Castings | ASTM A494 | Grade CW6MC (UNS N26625) | | ASTM A494 S2, S3 ASTM A781 S16 ASTM A957 S16 |
| | ASTM A494 | Grade CX2MW (UNS N26022) | | ASTM A494 S2, S3 ASTM A781 S16 ASTM A957 S16 |

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Repair of Defects

All major repairs as defined by A494 shall be documented in accordance with A781 S16 or A957 S16, as applicable.

The repair welding procedure shall be qualified in accordance with ASTM A488 or ISO 11970 and as follows:

- Welding shall be carried out with Ni-based consumable with enhanced Mo and Cr content compared to the base material;
- Welding procedure shall be qualified on the same cast material grade (UNS number) as used in production;
- Change of specific make of filler metal (brand names) requires requalification for SMAW and FCAW processes;
- A macro and corrosion test specimen shall include the weld zone;
- Testing methodology and acceptance criteria shall be in accordance with the requirements of this MDS for the parent material.

Examination of major repair welds on pressure containing parts shall also include RT.

Weld repairs are not acceptable for castings that leak during pressure testing.

Post weld heat treatment is required after all major weld repairs. If a minor cosmetic repair is required, heat treatment may be excluded providing the welding procedure meets all the specified microstructural, mechanical and corrosion material requirements of this data sheet in the as-welded condition.

Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^a

The material shall conform to the requirements of ISO 15156 /NACE MR0175 or ISO 17945/NACE MR0103, and this MDS.

The material shall be traceable in accordance with ISO 15156-3 /NACE MR0175-3 section 7.2 and this MDS.

Certification

The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser.

The inspection documents shall be issued in accordance with ISO 10474/ EN 10204 Type 3.1 and shall confirm compliance with this specification.

The inspection documents shall include the following information:

- Heat treatment condition (annealing temperature shall be stated);
- Melting and refining process;
- MPS identification or MCPR/QTR number used.

^a The supplementary suffix "S" designates a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

Material Data Sheet **MDS No. IN107S^a** **Rev. 01**

TYPE OF MATERIAL: Nickel alloy type 625

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|--------------|-----------|--------------------|------------------|---------------------------|
| Bars | ASTM B446 | UNS N06625 Grade 1 | | |

Page 1 of 1

Scope This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification.

Metal Making Basic electric furnace (EF) melt shall be refined by AOD or VOD followed by electro slag remelting (ESR) or vacuum arc remelting (VAR) or equivalent multiple refining methods. In alternative, vacuum induction melting (VIM) can be followed by single refining method such as ESR or VAR.

Heat Treatment Bars shall be placed in such a way as to ensure free circulation of heating and cooling media around each bar during the heat treatment process including any rapid cooling/quenching.

Non-Destructive Testing

Visual inspection
VT shall be carried out on each bar in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be cleaned prior to the testing.

NDT valve parts manufactured from bar
Inspection of valve parts manufactured from bar shall be according to the applicable valve specification. If a QSL is not specified by the purchaser, the requirements in this MDS shall apply including liquid penetrant testing according to the following table.

| NDE Requirement | Part manufactured from bar ^a |
|------------------------|---|
| Frequency ^b | 10 % |
| Method | ASME BPVC Sec. V, Article 6 |
| Extent ^c | 100 % |
| Acceptance criteria | ASME BPVC Sec. VIII, Div. 1, Appendix 8 |

NOTE The testing shall be carried out after machining, if applicable. Non-machined surfaces shall be pickled prior to the testing.

^a Part of size DN > 50 (NPS > 2).
^b For random examination (10 %), a minimum of one item per lot in any purchase order shall be examined. The test lot shall be as defined for mechanical testing.
^c All accessible internal and external surfaces shall be examined.

Repair of Defects Weld repair is not permitted.

Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^a

The material shall conform to the requirements of ISO 15156 /NACE MR0175 or ISO 17945 /NACE MR0103, and this MDS.

The material shall be traceable in accordance with ISO 15156-3 /NACE MR0175-3 section 7.2 and this MDS.

Surface Treatment and Finish Finished bars shall be pickled.

Marking The bars shall be marked to ensure full traceability to heat and heat treatment lot.

Certification

The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser.

The inspection documents shall be issued in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification.

The inspection documents shall include the following information:

- Heat treatment condition (annealing temperature shall be stated).

^a The supplementary suffix “S” designates a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| Material Data Sheet | | | | | MDS No. IN111S ^a | | Rev. 01 | |
|---|---|--------------------|-------------------------|----------------------------------|-----------------------------|--|---------|--|
| TYPE OF MATERIAL: Nickel alloy type 625 | | | | | | | | |
| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT | | | | |
| Seamless pipes and tubes | ASTM B444 | UNS N06625 Grade 1 | | | | | | |
| Page 1 of 1 | | | | | | | | |
| Scope | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | | | | | |
| Metal Making | Basic electric furnace (EF) melt shall be refined by AOD or VOD followed by electro slag remelting (ESR) or vacuum arc remelting (VAR) or equivalent multiple refining methods. In alternative, vacuum induction melting (VIM) can be followed by single refining method such as ESR or VAR. | | | | | | | |
| Heat Treatment | Pipes and tubes shall be placed in such a way as to ensure free circulation of heating and cooling media around each product during the heat treatment process including any rapid cooling/quenching. | | | | | | | |
| Repair of Defects | Weld repair is not permitted. | | | | | | | |
| Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^a | The material shall conform to the requirements of ISO 15156 /NACE MR0175 or ISO 17945 /NACE MR0103, and this MDS. | | | | | | | |
| | The material shall be traceable in accordance with ISO 15156-3 /NACE MR0175-3 section 7.2 and this MDS. | | | | | | | |
| Surface Treatment and Finish | Finished pipes and tubes shall be pickled. | | | | | | | |
| Marking | The pipes and tubes shall be marked to ensure full traceability to heat and heat treatment lot. | | | | | | | |
| Certification | <p>The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser.</p> <p>The inspection documents shall be issued in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification.</p> <p>The inspection documents shall include the following information:</p> <ul style="list-style-type: none"> - Heat treatment condition (annealing temperature shall be stated). | | | | | | | |
| ^a The supplementary suffix "S" designates a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service. | | | | | | | | |

Material Data Sheet **MDS No. IN119S^a** **Rev. 01**

TYPE OF MATERIAL: Nickel alloy type 625

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|---------------------|-----------------|--------------------|-------------------------|----------------------------------|
| HIP Products | ASTM B834 | UNS N06625 Grade 1 | | ASTM B834 S1, S2 |

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Scope This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification.

Qualification Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or NORSOK M-650. The qualification testing shall meet the requirements of this MDS.

Metal Making Gas atomized powder made from vacuum-refined metal. Powder blends shall be a homogenous mixture of powder heats in terms of composition, particle size and other properties.

Heat Treatment Components shall be placed in such a way as to ensure free circulation of heating and cooling media around each component during the heat treatment process including any rapid cooling/quenching.

Non-Destructive Testing

Visual Inspection
VT shall be carried out on each item in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be pickled prior to the testing.

Liquid penetrant testing

| NDE Requirement | HIP product^a |
|------------------------|---|
| Frequency ^b | 10 % |
| Method | ASME BPVC Sec. V, Article 6 |
| Extent ^c | 100 % |
| Acceptance criteria | ASME BPVC Sec. VIII, Div. 1, Appendix 8 |

NOTE The testing shall be carried out after machining, if applicable. Non-machined surfaces shall be pickled prior to the testing.

^a Parts of size DN > 50 (NPS > 2).
^b For random examination (10 %), a minimum of one item per lot in any purchase order shall be examined. The test lot shall be as defined for mechanical testing.
^c All accessible internal and external surfaces shall be examined.

Repair of Defects Weld repair is not permitted.

Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^a

The material shall conform to the requirements of ISO 15156 /NACE MR0175 or ISO 17945 /NACE MR0103, and this MDS.

The material shall be traceable in accordance with ISO 15156-3 /NACE MR0175-3 section 7.2 and this MDS.

Surface Treatment and Finish Finished components shall be pickled. Machined surfaces do not require pickling.

Marking The powder blend shall have a unique identity marked on the powder container and this identity shall be recorded and maintained throughout production of the product. The components shall be marked to ensure full traceability to heat and heat treatment lot.

Certification

The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser.

The inspection documents shall be issued in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification.

The inspection documents shall include the following information:

- Manufacturer of the starting material (powder) for the finished product;
- Heat treatment condition (annealing temperature shall be stated);
- MPS identification or MCPR/QTR number used.

^a The supplementary suffix "S" designates a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| Material Data Sheet | | MDS No. IN120S ^a | | Rev. 01 |
|---|---|-----------------------------|------------------|---------------------------|
| TYPE OF MATERIAL: Nickel alloys | | | | |
| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
| Bolting | API STD 6ACRA | UNS N07718 | 120K | ASTM A962 S56 |
| Page 1 of 1 | | | | |
| Scope | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| Qualification | Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or NORSOK M-650. The qualification testing shall meet the requirements of this MDS. | | | |
| Manufacturing | Manufacturing general requirements shall be according to ASTM A962 as amended by this MDS. Threads on studs and bolts shall be made by cold rolling after precipitation hardening. Threads in nuts shall be machined. | | | |
| Heat Treatment | Solution annealing and ageing heat treatment shall be carried out after the final hot forming operation. | | | |
| Impact Testing/ Toughness testing | The impact testing requirements of API6ACRA shall apply. | | | |
| Hardness | Maximum hardness 40HRC. Hardness shall not be tested in the threaded area. | | | |
| Macro Etch/ Micrographic Examination | Bolting shall be examined in accordance with API6ACRA and meet the required acceptance criteria. | | | |
| Proof Load Testing | Proof load testing shall be carried out in accordance with ASTM A194 and the acceptance criteria shall comply with the requirements for Grade 7. | | | |
| Extent of Testing | For heat treatment in continuous furnace a heat treatment load (lot) is defined as all bolting heat treated continuously in the same furnace, or maximum for 8 h of operation, of the same heat and nominal thickness. | | | |
| Non-Destructive Testing | <p><u>Visual Inspection</u> All products shall be 100 % visually examined in all areas of threads, shanks, and heads. Discontinuities shall comply with requirements specified in ASTM F788 for bolts/studs and ASTM F812 for nuts.</p> <p><u>Liquid Penetrant Testing</u> Liquid penetrant testing shall be according to ASTM A962. Supplementary requirement S56 shall apply to 10 % of the bolting.</p> | | | |
| Repair of Defects | Weld repair is not permitted. | | | |
| Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^a | <p>The material shall conform to the requirements of ISO 15156 /NACE MR0175 or ISO 17945 /NACE MR0103, and this MDS.</p> <p>The material shall be traceable in accordance with ISO 15156-3 /NACE MR0175-3 section 7.2 and this MDS.</p> | | | |
| Surface Treatment and Finish | White pickled. | | | |
| Marking | Each bolting shall be marked to ensure full traceability to melt and heat treatment lot. | | | |
| Certification | <p>The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser.</p> <p>The inspection documents shall be issued in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification.</p> <p>The inspection documents shall include the following information:</p> <ul style="list-style-type: none"> - The MPS identification or the MCPR/QTR number used; - Steel manufacturer, melting and refining practice; - Heat treatment condition. Solution annealing temperature, quenching medium, ageing temperature and holding time shall be stated. | | | |
| ^a The supplementary suffix "S" designates a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service. | | | | |

Material Data Sheet **MDS No. IR111 / IR111S^a** **Rev. 01**

TYPE OF MATERIAL: Austenitic Stainless Steel, Type 6Mo

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|---------------------|-----------------|--------------|-------------------------|----------------------------------|
| Seamless pipes | ASTM A312 | UNS S31254 | | |
| | ASTM A312 | UNS N08367 | | |
| | ASTM A312 | UNS N08926 | | |

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| | |
|---|--|
| Scope | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. |
| Qualification | Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or NORSOK M-650. The qualification testing shall meet the requirements of this MDS. |
| Metal Making | The melt shall be refined by AOD or equivalent method. |
| Chemical Composition | PREN ≥ 40.0 |
| Heat Treatment | The pipes shall be solution annealed followed by rapid cooling. Pipes shall be placed in such a way as to ensure free circulation of heating and cooling media around each pipe during the heat treatment process including quenching. |
| Corrosion testing | Corrosion test according to ASTM G48 Method A is required. Test temperature shall be 50 °C (122 °F) and the exposure time 24 h. The test shall expose the external and internal surfaces and a cross section surface in full wall thickness. Cut edges shall be prepared according to ASTM G48. The complete specimen shall be pickled before being weighed and tested. Pickling may be performed for 5 min at 60 °C (140 °F) in a solution of 20 % HNO ₃ + 5 % HF. The acceptance criteria are: <ul style="list-style-type: none"> - No pitting at 20x magnification; - The weight loss shall be less than 4.0 g/m². |
| Extent of Testing | One tensile and corrosion test shall be carried out for each heat and heat treatment lot. |
| Repair of Defects | Weld repair is not permitted. |
| Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^a | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of ISO 15156 /NACE MR0175 or ISO 17945 /NACE MR0103, and this MDS: <u>Hardness testing</u> Production hardness testing shall be performed in accordance with the requirements in ASTM A370/A1058 on one length of pipe per lot. The maximum hardness shall be 35HRC from three readings taken in close proximity. The material shall be traceable in accordance with ISO 15156-3 /NACE MR0175-3 section 7.2 and this MDS. |
| Surface Treatment and Finish | Finished pipes shall be pickled or bright annealed. |
| Marking | The pipes shall be marked to ensure full traceability to heat and heat treatment lot. |
| Certification | The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser. The inspection documents shall be in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification. The inspection documents shall include the following information: <ul style="list-style-type: none"> - MPS identification or MCP/R/QTR number used; - Steel manufacturer; - Solution annealing temperature, holding time and quench medium shall be stated (holding time is not applicable for pipes produced hot finished and direct quenched). |

^a The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| Material Data Sheet | | MDS No. IR112 / IR112S ^a | | Rev. 01 |
|---|--|-------------------------------------|------------------|---------------------------|
| TYPE OF MATERIAL: Austenitic Stainless Steel, Type 6Mo | | | | |
| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
| Welded Pipes | ASTM A358 | UNS S31254 | Class 1, 3 and 5 | ASTM A358 S3 |
| | ASTM A358 | UNS N08367 | Class 1, 3 and 5 | ASTM A358 S3 |
| | ASTM A358 | UNS N08926 | Class 1, 3 and 5 | ASTM A358 S3 |
| Page 1 of 2 | | | | |
| Scope | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| Qualification | Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or NORSOK M-650. The qualification testing shall meet the requirements of this MDS. | | | |
| Metal Making | The melt shall be refined by AOD or equivalent method. | | | |
| Chemical Composition | PREN ≥ 40.0 | | | |
| Welding | The WPS shall be qualified in accordance with ASME BPVC Sec. IX or ISO 15614-1 and this MDS: <ul style="list-style-type: none"> - A matching consumable with enhanced Mo or Cr content compared to the base material shall be used; the S content of the consumable shall not exceed 0.015 %. - The welding procedure qualification shall be corrosion tested as specified below. - The qualification shall be carried out on the same material grade (UNS number) as used in production. - A change of specific make (brand name) of welding consumables requires requalification. | | | |
| Heat Treatment | The pipes shall be solution annealed followed by rapid cooling. Pipes shall be placed in such a way as to ensure free circulation of heating and cooling media around each pipe during the heat treatment process including quenching. Post weld solution annealing is not required for pipes with nominal wall thickness up to 7.11 mm (0.28 in) manufactured from solution annealed strip/plate material; such pipe shall be marked as stated in A358. | | | |
| Corrosion testing | Corrosion test according to ASTM G48 Method A is required. Test temperature shall be 50 °C (122 °F) and the exposure time 24 h. The test shall expose the external and internal surfaces and a cross section surface in full wall thickness. Cut edges shall be prepared according to ASTM G48. The complete specimen shall be pickled before being weighed and tested. Pickling may be performed for 5 min at 60 °C (140 °F) in a solution of 20 % HNO ₃ + 5 % HF. The acceptance criteria are: <ul style="list-style-type: none"> - No pitting at 20x magnification; - The weight loss shall be less than 4.0 g/m². | | | |
| Extent of Testing | One tensile and corrosion test shall be carried out for each lot as defined below: <ul style="list-style-type: none"> - For batch heat treatment, a lot is defined as maximum 60 m (197 ft) of pipes of the same heat, same processing conditions including weld procedure, same size and heat treatment load. - For continuous heat treatment, a lot is defined as maximum 60 m (197 ft) of pipes of the same heat, same processing conditions including weld procedure, same size and which is heat treated the same day. | | | |
| Non-Destructive Testing | Eddy current testing according to ASTM A450 is acceptable as replacement for radiography for wall thickness less than 4.0 mm (0.16 in). ASTM A358 supplementary requirement S3 shall apply to the longitudinal weld ends of 10 % of pipes per lot. The weld of each examined pipe shall be ground flush for a length of 100 mm (4 in) prior to penetrant testing. Method of testing shall be according to ASME Sec. V Article 6 and acceptance criteria shall be to ASME BPVC Sec. VIII, Div. 1, Appendix 8. The testing shall be carried out after any calibration. | | | |
| Repair of Defects | Weld repair of base material is not permitted. For repair of welds, the requirements for production welding above shall apply to the repair WPS. Repair welds shall be heat treated as per original production weld. | | | |

Material Data Sheet **MDS No. IR112 / IR112S^a** **Rev. 01**

TYPE OF MATERIAL: Austenitic Stainless Steel, Type 6Mo

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|---------------------|-----------------|--------------|-------------------------|----------------------------------|
| Welded Pipes | ASTM A358 | UNS S31254 | Class 1, 3 and 5 | ASTM A358 S3 |
| | ASTM A358 | UNS N08367 | Class 1, 3 and 5 | ASTM A358 S3 |
| | ASTM A358 | UNS N08926 | Class 1, 3 and 5 | ASTM A358 S3 |

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| Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^a | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of ISO 15156 /NACE MR0175 or ISO 17945 /NACE MR0103, and the following additional requirements to the MDS: |
| | <u>Hardness testing</u> Production testing shall be performed in accordance with the requirements in ASTM A370/A1058 on one length of pipe per lot. The maximum hardness of the base material, HAZ and weld metal shall be 35HRC from three readings taken in close proximity at each location. |
| | The material shall be traceable in accordance with ISO 15156-3 /NACE MR0175-3 section 7.2 and this MDS. |

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| Surface Treatment and Finish | Finished pipes shall be pickled or bright annealed. |
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| Marking | The pipes shall be marked to ensure full traceability to heat and heat treatment lot. |
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| Certification | <p>The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser.</p> <p>The inspection documents shall be in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification.</p> <p>The inspection documents shall include the following information:</p> <ul style="list-style-type: none"> - MPS identification or MCPR/QTR number used; - Steel manufacturer; - Solution annealing temperature, holding time and quench medium shall be stated. |
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^a The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

Material Data Sheet**MDS No. IR113 / IR113S^a****Rev. 01**

TYPE OF MATERIAL: Austenitic Stainless Steel, Type 6Mo

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|------------------|-----------|------------|----------------------|---------------------------|
| Wrought fittings | ASTM A403 | UNS S31254 | WP-S, WP-WX and WP-W | ASTM A960 S52 |
| | ASTM A403 | UNS N08367 | WP-S, WP-WX and WP-W | ASTM A960 S52 |
| | ASTM A403 | UNS N08926 | WP-S, WP-WX and WP-W | ASTM A960 S52 |

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| Scope | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. |
| Qualification | Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or Norsok M-650. The qualification testing shall meet the requirements of this MDS. |
| Metal Making | The melt shall be refined by AOD or equivalent method. |
| Chemical Composition | PREN ≥ 40.0 |
| Welding | <p>The welding procedure shall be qualified in accordance with ASME IX or ISO 15614-1 and this MDS:</p> <ul style="list-style-type: none"> - A matching consumable with enhanced Mo or Cr content compared to the base material shall be used; the S content of the consumable shall not exceed 0.015 %. - The welding procedure qualification shall be corrosion tested as specified below. - The qualification shall be carried out on the same material grade (UNS number) as used in production. - A change of specific make (brand name) of welding consumables requires requalification. |
| Heat Treatment | <p>The fittings shall be solution annealed followed by water/liquid quenching.</p> <p>Fittings shall be placed in such a way as to ensure free circulation of heating and cooling media around each fitting during the heat treatment process including quenching.</p> |
| Corrosion testing | <p>Corrosion test according to ASTM G48 Method A is required. Test temperature shall be 50 °C (122 °F) and the exposure time 24 h. The test shall expose the external and internal surfaces and a cross section surface in full wall thickness. Cut edges shall be prepared according to ASTM G48. The complete specimen shall be pickled before being weighed and tested. Pickling may be performed for 5 min at 60 °C (140 °F) in a solution of 20 % HNO₃ + 5 % HF.</p> <p>The acceptance criteria are:</p> <ul style="list-style-type: none"> - No pitting at 20x magnification; - The weight loss shall be less than 4.0 g/m². |
| Extent of Testing | <p>One tensile and corrosion test shall be carried out for each lot as defined below.</p> <p>A test lot shall include all fittings from the same heat and heat treatment load, with a wall thickness range of ±5 mm (±0.2 in) and, where applicable, welded with the same WPS.</p> |
| Test Sampling | Production testing shall be carried out on specimens cut from a fitting, where dimensions permit. When removal of specimens is not possible due to the size of the fitting, a prolongation or a length of starting material that has been heat treated in the same heat treatment load as the fittings it represents shall be used. |

Material Data Sheet**MDS No. IR113 / IR113S^a****Rev. 01**

TYPE OF MATERIAL: Austenitic Stainless Steel, Type 6Mo

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|------------------|-----------|------------|----------------------|---------------------------|
| Wrought fittings | ASTM A403 | UNS S31254 | WP-S, WP-WX and WP-W | ASTM A960 S52 |
| | ASTM A403 | UNS N08367 | WP-S, WP-WX and WP-W | ASTM A960 S52 |
| | ASTM A403 | UNS N08926 | WP-S, WP-WX and WP-W | ASTM A960 S52 |

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| Non-Destructive Testing | <p><u>Liquid penetrant testing</u></p> <p>ASTM A960 Supplementary requirement S52 shall apply as amended by this MDS:</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th rowspan="2" style="width: 25%;">NDE Requirement</th> <th colspan="2" style="text-align: center;">Nominal Thickness</th> </tr> <tr> <th style="text-align: center;">Seamless fittings</th> <th style="text-align: center;">Welded fittings^a</th> </tr> </thead> <tbody> <tr> <td>Frequency^b</td> <td style="text-align: center;">10 %</td> <td style="text-align: center;">100 %</td> </tr> <tr> <td>Method</td> <td colspan="2" style="text-align: center;">ASME BPVC Sec. V, Article 6</td> </tr> <tr> <td>Extent^c</td> <td colspan="2" style="text-align: center;">100 %</td> </tr> <tr> <td>Acceptance criteria</td> <td colspan="2" style="text-align: center;">ASME BPVC Sec. VIII, Div. 1, Appendix 8</td> </tr> </tbody> </table> <p>NOTE The testing shall be carried out after machining, if applicable. Non-machined surfaces shall be pickled prior to the testing.</p> <p>^a Welded fittings of size DN > 50 (NPS > 2).</p> <p>^b Frequency of inspection 100 % means that each item shall be examined. When random examination (10 %) is specified, a minimum of one item per lot in any purchase order shall be examined. The test lot shall be as defined for mechanical testing.</p> <p>^c All accessible internal and external surfaces shall be examined. For welded fittings, the testing shall cover the weld only and the weld of each examined fitting shall be ground flush in a length of 100 mm (4 in) prior to penetrant testing</p> | NDE Requirement | Nominal Thickness | | Seamless fittings | Welded fittings ^a | Frequency ^b | 10 % | 100 % | Method | ASME BPVC Sec. V, Article 6 | | Extent ^c | 100 % | | Acceptance criteria | ASME BPVC Sec. VIII, Div. 1, Appendix 8 | |
|--------------------------------|---|------------------------------|-------------------|--|-------------------|------------------------------|------------------------|------|-------|--------|-----------------------------|--|---------------------|-------|--|---------------------|---|--|
| NDE Requirement | Nominal Thickness | | | | | | | | | | | | | | | | | |
| | Seamless fittings | Welded fittings ^a | | | | | | | | | | | | | | | | |
| Frequency ^b | 10 % | 100 % | | | | | | | | | | | | | | | | |
| Method | ASME BPVC Sec. V, Article 6 | | | | | | | | | | | | | | | | | |
| Extent ^c | 100 % | | | | | | | | | | | | | | | | | |
| Acceptance criteria | ASME BPVC Sec. VIII, Div. 1, Appendix 8 | | | | | | | | | | | | | | | | | |

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| Repair of Defects | <p>Weld repair of base material is not permitted.</p> <p>For repair of welds, the requirements for production welding above shall apply to the repair WPS. Repair welds shall be heat treated as per the original production weld.</p> |
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| Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^a | <p>When sour service requirements are specified by the purchaser, the material shall conform to the requirements of ISO 15156 /NACE MR0175 or ISO 17945 /NACE MR0103, and this MDS:</p> <p><u>Hardness testing</u></p> <p>Production testing shall be performed in accordance with the requirements in ASTM A370/A1058 on two fittings per lot. When only one fitting is produced, it shall be hardness tested as required. The maximum hardness of the base material, HAZ and weld metal shall be 35HRC from three readings taken in close proximity at each location.</p> <p>The material shall be traceable in accordance with ISO 15156-3 /NACE MR0175-3 section 7.2 and this MDS.</p> |
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| Surface Treatment and Finish | Finished fittings shall be pickled. Machined surfaces do not require pickling. |
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| Marking | The fittings shall be marked to ensure full traceability to heat and heat treatment lot. |
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| Certification | <p>The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser.</p> <p>The inspection documents shall be in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification.</p> <p>The inspection documents shall include the following information:</p> <ul style="list-style-type: none"> - MPS identification or MCPR/QTR number used; - Steel manufacturer; - Solution annealing temperature, holding time and quench medium shall be stated. |
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^a The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| Material Data Sheet | | MDS No. IR114 / IR114S ^a | | Rev. 01 |
|---|---|-------------------------------------|------------------|----------------------------|
| TYPE OF MATERIAL: Austenitic Stainless Steel, Type 6Mo | | | | |
| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
| Forgings | ASTM A182 | F44 (UNS S31254) | | ASTM A961 S56 |
| | ASTM A182 | F62 (UNS N08367) | | ASTM A961 S56 |
| | ASTM B462 | UNS N08926 | | ASME BPVC Code Case 2120-1 |
| Page 1 of 2 | | | | |
| Scope | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. Product covered by this MDS is limited to a maximum thickness of 200 mm (8 in). For thickness exceeding 200 mm (8 in), qualification and specification requirements shall be subject to agreement. | | | |
| Qualification | Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or NORSOK M-650. The qualification testing shall meet the requirements of this MDS. | | | |
| Metal Making | The melt shall be refined by AOD or equivalent method. | | | |
| Chemical Composition | PREN ≥ 40.0 | | | |
| Heat Treatment | The forgings shall be solution annealed followed by water/liquid quenching. Forgings shall be placed in such a way as to ensure free circulation of heating and cooling media around each component during the heat treatment process including quenching. | | | |
| Corrosion testing | Corrosion test according to ASTM G48 Method A is required. Test temperature shall be 50 °C (122 °F) and the exposure time 24 h. The test shall expose the external and internal surfaces and a cross section surface in full wall thickness. For forgings with wall thickness less than 100 mm (4 in) the test specimen shall expose a cross section from surface to mid-thickness. For greater wall thickness the specimen shall expose a cross section from surface to a depth of 50mm (2 in). Cut edges shall be prepared according to ASTM G48. The complete specimen shall be pickled before being weighed and tested. Pickling may be performed for 5 min at 60 °C (140 °F) in a solution of 20 % HNO ₃ + 5 % HF. The acceptance criteria are: <ul style="list-style-type: none"> - No pitting at 20x magnification; - The weight loss shall be less than 4.0 g/m² | | | |
| Extent of Testing | One tensile and corrosion test shall be carried out for each lot as defined below: <ul style="list-style-type: none"> - A test lot shall include all forgings from the same heat, heat treatment load and shall not exceed 2 000 kg (4 400 lb) for forgings with as forged weight 50 kg (110 lb), and 5 000 kg (11 000 lb) for forgings with as forged weight > 50 kg (110 lb). - For forgings having maximum section thickness, T ≤ 50 mm (2 in), the test specimen shall be taken at mid thickness and its mid length shall be at least 50 mm (2 in) from any second surface or at equal distance from the second surfaces. - For forgings having maximum section thickness, T > 50 mm (2 in), the test specimens shall be taken at least ¼T from the nearest surface and mid-length of test specimens at least T or 100 mm (4 in), whichever is less, from any second surface. - Sketches shall be established showing type, and size of test samples and location for extraction of test specimens. | | | |
| Non-Destructive Testing | <u>Visual Inspection</u> VT shall be carried out on each forging or bar in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be pickled prior to the testing. | | | |

Material Data Sheet **MDS No. IR114 / IR114S^a** **Rev. 01**

TYPE OF MATERIAL: Austenitic Stainless Steel, Type 6Mo

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|--------------|-----------|------------------|------------------|----------------------------|
| Forgings | ASTM A182 | F44 (UNS S31254) | | ASTM A961 S56 |
| | ASTM A182 | F62 (UNS N08367) | | ASTM A961 S56 |
| | ASTM B462 | UNS N08926 | | ASME BPVC Code Case 2120-1 |

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|--|--|---|
| Non-Destructive Testing | <u>Liquid penetrant testing</u> | |
| | NDE Requirement | Forgings^a |
| | Frequency ^b | 10 % |
| | Method | ASME BPVC Sec. V, Article 6 |
| | Extent ^c | 100 % |
| | Acceptance criteria | ASME BPVC Sec. VIII, Div. 1, Appendix 8 |
| <p>NOTE The testing shall be carried out after machining, if applicable. Non-machined surfaces shall be pickled prior to the testing.</p> <p>^a Parts of size DN > 50 (NPS > 2).</p> <p>^b For random examination (10 %), a minimum of one item per lot in any purchase order shall be examined. The test lot shall be as defined for mechanical testing.</p> <p>^c All accessible internal and external surfaces shall be examined.</p> | | |
| <u>Valve forgings NDT</u> | | |
| Inspection shall be according to the applicable valve specification. If a QSL is not specified by the purchaser, the requirements in this MDS shall apply. | | |
| Repair of Defects | Weld repair is not permitted. | |
| Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^a | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of ISO 15156 /NACE MR0175 or ISO 17945 /NACE MR0103, and this MDS: | |
| | <u>Hardness testing</u> | |
| | Production hardness testing shall be performed in accordance with the requirements in ASTM A370/A1058 on two forgings per lot. When only one part is produced, it shall be hardness tested as required. The maximum hardness shall be 35HRC from three readings taken in close proximity. | |
| The material shall be traceable in accordance with ISO 15156-3 /NACE MR0175-3 section 7.2 and this MDS. | | |
| Surface Treatment and Finish | Finished forgings shall be pickled. Machined surfaces do not require pickling. | |
| Marking | The forgings shall be marked to ensure full traceability to heat and heat treatment lot. | |
| Certification | <p>The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser.</p> <p>The inspection documents shall be in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification.</p> <p>The inspection documents shall include the following information:</p> <ul style="list-style-type: none"> - MPS identification or MCPR/QTR number used; - Steel manufacturer; - Solution annealing temperature, holding time and quench medium shall be stated. | |

^a The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

Material Data Sheet **MDS No. IR115 / IR115S^a** **Rev. 01**

| <i>TYPE OF MATERIAL: Austenitic Stainless Steel, Type 6Mo</i> | | | | |
|---|--|--------------|-------------------------|----------------------------------|
| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
| Plates, sheets, strips | ASTM A240 | UNS S31254 | | |
| | ASTM A240 | UNS N08367 | | |
| | ASTM A240 | UNS N08926 | | |
| Page 1 of 2 | | | | |
| Scope | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| Manufacturing | Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or NORSOK M-650. The qualification testing shall meet the requirements of this MDS. | | | |
| Metal Making | The melt shall be refined by AOD or equivalent method. | | | |
| Chemical Composition | PREN ≥ 40.0 | | | |
| Tensile Testing | Tensile test specimens shall be sampled in the transverse orientation to the direction of final rolling. | | | |
| Corrosion testing | <p>Corrosion test according to ASTM G48 Method A is required. Test temperature shall be 50 °C (122 °F) and the exposure time 24 h. The test shall expose the external and internal surfaces and a cross section surface in full wall thickness. Cut edges shall be prepared according to ASTM G48. The complete specimen shall be pickled before being weighed and tested. Pickling may be performed for 5 min at 60 °C (140 °F) in a solution of 20 % HNO₃ + 5 % HF.</p> <p>The acceptance criteria are:</p> <ul style="list-style-type: none"> - No pitting at 20x magnification; - Weight loss shall be less than 4.0 g/m². | | | |
| Extent of Testing | One tensile and corrosion test shall be carried out for each heat of steel and heat treatment lot. | | | |
| Non-Destructive Testing | <p><u>Visual Inspection</u></p> <p>VT shall be carried out on each plate in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be cleaned prior to the testing.</p> <hr/> <p><u>Valve plate NDT</u></p> <p>Inspection shall be according to the applicable valve specification. If a QSL is not specified by the purchaser, the requirements in this MDS shall apply.</p> | | | |
| Repair of Defects | Weld repair is not permitted. | | | |
| Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^a | <p>When sour service requirements are specified by the purchaser, the material shall conform to the requirements of ISO 15156 /NACE MR0175 or ISO 17945 /NACE MR0103, and this MDS.</p> <hr/> <p><u>Hardness testing</u></p> <p>Production testing shall be performed in accordance with the requirements in ASTM A370/A1058 on one plate per lot. For coil, tests shall be carried out at both ends of the coil. The maximum hardness shall be 35HRC from three readings taken in close proximity at each location.</p> <hr/> <p>The material shall be traceable in accordance with ISO 15156-3 /NACE MR0175-3 section 7.2 and this MDS.</p> | | | |
| Surface Treatment and Finish | Finished plates, sheets and strips shall be pickled. | | | |
| Marking | The plates, sheets and strips shall be marked to ensure full traceability to heat and heat treatment lot. | | | |

| Material Data Sheet | | | | | MDS No. IR115 / IR115S ^a | | Rev. 01 | |
|--|--|------------|------------------|---------------------------|-------------------------------------|--|---------|--|
| TYPE OF MATERIAL: Austenitic Stainless Steel, Type 6Mo | | | | | | | | |
| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT | | | | |
| Plates, sheets, strips | ASTM A240 | UNS S31254 | | | | | | |
| | ASTM A240 | UNS N08367 | | | | | | |
| | ASTM A240 | UNS N08926 | | | | | | |
| Page 2 of 2 | | | | | | | | |
| Certification | <p>The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser.</p> <p>The inspection documents shall be in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification.</p> <p>The inspection documents shall include the following information:</p> <ul style="list-style-type: none"> - MPS identification or MCPR/QTR number used; - Steel manufacturer; - Solution annealing temperature, holding time and quench medium shall be stated. | | | | | | | |
| <p>^a The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.</p> | | | | | | | | |

| Material Data Sheet | | | | | MDS No. IR116 / IR116S ^a | | Rev. 01 | |
|---|--|----------------------|------------------|--|-------------------------------------|--|---------|--|
| TYPE OF MATERIAL: Austenitic Stainless Steel, Type 6Mo | | | | | | | | |
| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT | | | | |
| Castings | ASTM A351 | CK3MCuN (UNS J93254) | | ASTM A351 S5, S6, ASTM A703 S20 ASTM A985 S20 | | | | |
| | ASTM A351 | CN3MN (UNS J94651) | | ASTM A351 S5, S6, ASTM A703 S20 ASTM A985 S20 | | | | |
| Page 1 of 4 | | | | | | | | |
| Scope | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. For castings produced by the investment casting process, the requirements of ASTM A985 and this MDS shall apply. | | | | | | | |
| Qualification | Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or NORSOK M-650. The qualification testing shall meet the requirements of this MDS. | | | | | | | |
| Metal Making | The melt shall be refined by AOD or equivalent method. Induction melting of AOD refined ingot or equally refined scrap as permitted by ISO 17782 is regarded to be equivalent to AOD refined materials. | | | | | | | |
| Chemical Composition | P ≤ 0.030 % PREN ≥ 40.0 | | | | | | | |
| Heat Treatment | Material shall be solution annealed at temperature ≥ 1 225 °C (2 237 °F) followed by water/liquid quenching. Castings shall be placed in such a way as to ensure free circulation of heating and cooling media around each pipe during the heat treatment process including quenching. | | | | | | | |
| Corrosion testing | Corrosion test according to ASTM G48 Method A is required. Test temperature shall be 50 °C (122 °F) and the exposure time 24 h. The test shall expose the external and internal surfaces and a cross section surface in full wall thickness. Cut edges shall be prepared according to ASTM G48. The complete specimen shall be pickled before being weighed and tested. Pickling may be performed for 5 min at 60 °C (140 °F) in a solution of 20 % HNO ₃ + 5 % HF. The acceptance criteria are: <ul style="list-style-type: none"> - No pitting at 20x magnification; - The weight loss shall be less than 4.0 g/m². | | | | | | | |
| Extent of Testing | One tensile and corrosion test shall be carried out for each heat of steel and heat treatment load (including any PWHT). A test lot shall not exceed 5 000 kg (11 000 lb) in weight. | | | | | | | |

Material Data Sheet **MDS No. IR116 / IR116S^a** **Rev. 01**

TYPE OF MATERIAL: *Austenitic Stainless Steel, Type 6Mo*

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|--------------|-----------|----------------------|------------------|---|
| Castings | ASTM A351 | CK3MCuN (UNS J93254) | | ASTM A351 S5, S6, ASTM A703 S20 ASTM A985 S20 |
| | ASTM A351 | CN3MN (UNS J94651) | | ASTM A351 S5, S6, ASTM A703 S20 ASTM A985 S20 |

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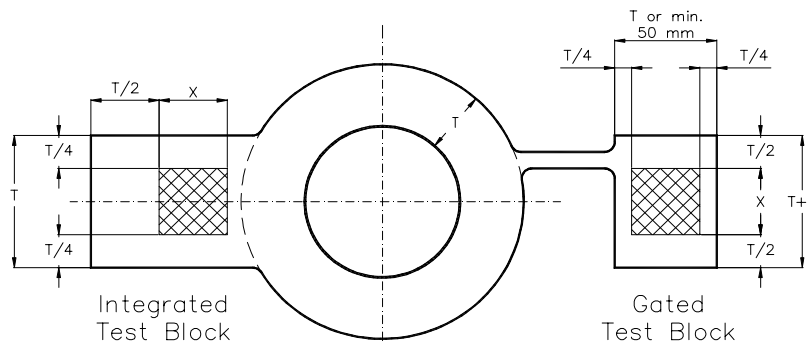
Test Sampling

Test blocks shall be integral or gated with the casting(s) they represent and shall accompany the castings through all heat treatment operations.

Thickness of the test block shall be equal to the thickest part of the casting represented. For flanged castings, the largest flange thickness is the ruling section.

Dimensions of test blocks and location of test specimens within the test blocks are shown in the figure below. The test specimens shall be taken within the cross hatched area and in a distance of T/4 from the ends.

During any PWHT the test block shall be tack welded onto the casting.



Material Data Sheet**MDS No. IR116 / IR116S^a****Rev. 01**

TYPE OF MATERIAL: Austenitic Stainless Steel, Type 6Mo

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|--------------|-----------|----------------------|------------------|--|
| Castings | ASTM A351 | CK3MCuN (UNS J93254) | | ASTM A351 S5, S6, ASTM A703 S20 ASTM A985 S20 |
| | ASTM A351 | CN3MN (UNS J94651) | | ASTM A351 S5, S6, ASTM A703 S20 ASTM A985 S20 |

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| Non-Destructive Testing | <p><u>Radiographic testing</u></p> <p>ASTM A351 supplementary requirement S5 shall apply as amended by this MDS:</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th rowspan="2" style="width: 15%;">NDE requirement</th> <th rowspan="2" style="width: 10%;">Pilot casting (section 4.8)</th> <th colspan="4">Production casting</th> </tr> <tr> <th colspan="3">Valve castings^a</th> <th>Other pressure containing castings^b</th> </tr> </thead> <tbody> <tr> <td rowspan="7">Frequency^c</td> <td rowspan="7">100 %</td> <th style="width: 5%;">NPS</th> <th style="width: 5%;">DN</th> <th colspan="2">Pressure class</th> <td rowspan="7">100 %</td> </tr> <tr> <td></td> <td></td> <th style="width: 10%;">≤ 300</th> <th style="width: 10%;">600</th> <th style="width: 10%;">900</th> <th style="width: 10%;">≥ 1500</th> </tr> <tr> <td>< 2</td> <td>< 50</td> <td>N/R</td> <td>N/R</td> <td>N/R</td> <td>N/R</td> </tr> <tr> <td>≥ 2</td> <td>≥ 50</td> <td>N/R</td> <td>5 %</td> <td>5 %</td> <td>5 %</td> </tr> <tr> <td>≥ 6</td> <td>≥ 150</td> <td>N/R</td> <td>5 %</td> <td>5 %</td> <td>100 %</td> </tr> <tr> <td>≥ 10</td> <td>≥ 250</td> <td>5 %</td> <td>5 %</td> <td>5 %</td> <td>100 %</td> </tr> <tr> <td>≥ 16</td> <td>≥ 400</td> <td>5 %</td> <td>5 %</td> <td>100 %</td> <td>100 %</td> </tr> <tr> <td>≥ 20</td> <td>≥ 500</td> <td>5 %</td> <td>100 %</td> <td>100 %</td> <td>100 %</td> </tr> </tbody> </table> | | | | | NDE requirement | Pilot casting (section 4.8) | Production casting | | | | Valve castings ^a | | | Other pressure containing castings ^b | Frequency ^c | 100 % | NPS | DN | Pressure class | | 100 % | | | ≤ 300 | 600 | 900 | ≥ 1500 | < 2 | < 50 | N/R | N/R | N/R | N/R | ≥ 2 | ≥ 50 | N/R | 5 % | 5 % | 5 % | ≥ 6 | ≥ 150 | N/R | 5 % | 5 % | 100 % | ≥ 10 | ≥ 250 | 5 % | 5 % | 5 % | 100 % | ≥ 16 | ≥ 400 | 5 % | 5 % | 100 % | 100 % | ≥ 20 | ≥ 500 | 5 % | 100 % | 100 % | 100 % |
|--|--|-----------------------------|-------|--------------------|---|-----------------|-----------------------------|--------------------|--|--|--|-----------------------------|--|--|---|------------------------|-------|-----|----|----------------|--|-------|--|--|-------|-----|-----|--------|-----|------|-----|-----|-----|-----|-----|------|-----|-----|-----|-----|-----|-------|-----|-----|-----|-------|------|-------|-----|-----|-----|-------|------|-------|-----|-----|-------|-------|------|-------|-----|-------|-------|-------|
| NDE requirement | Pilot casting (section 4.8) | Production casting | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | Valve castings ^a | | | Other pressure containing castings ^b | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Frequency ^c | 100 % | NPS | DN | Pressure class | | 100 % | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | ≤ 300 | 600 | | 900 | ≥ 1500 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | < 2 | < 50 | N/R | N/R | | N/R | N/R | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | ≥ 2 | ≥ 50 | N/R | 5 % | | 5 % | 5 % | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | ≥ 6 | ≥ 150 | N/R | 5 % | | 5 % | 100 % | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | ≥ 10 | ≥ 250 | 5 % | 5 % | | 5 % | 100 % | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | ≥ 16 | ≥ 400 | 5 % | 5 % | | 100 % | 100 % | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ≥ 20 | ≥ 500 | 5 % | 100 % | 100 % | 100 % | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Method | ASME BPVC Sec. V, Article 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Extent | Areas defined by ASME B16.34 for special class valves, at abrupt changes in sections and at the junctions of risers, gates or feeders to the casting | | | 100 % ^d | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Acceptance criteria | ASME BPVC Sec. VIII, Div. 1, Appendix 7 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| <p>NOTE N/R means not required, unless specified otherwise by the purchaser.</p> <p>^a Production valve casting, RT shall be according to the applicable valve specification. If a QSL is not specified by the purchaser, the requirements in this table shall apply.</p> <p>^b Production casting other than valve casting.</p> <p>^c Frequency of inspection 100 % means that each item shall be examined. When random examination (5 %) is specified, a minimum of one item per lot of each pattern in any purchase order shall be examined.</p> <p>^d Production casting other than valve casting, inspection shall include other critical areas as defined in the purchase order and/or applicable product specification or standard. Sketches of the areas to be tested shall be established and agreed with the purchaser.</p> | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Material Data Sheet **MDS No. IR116 / IR116S^a** **Rev. 01**

TYPE OF MATERIAL: Austenitic Stainless Steel, Type 6Mo

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|---------------------|-----------------|----------------------|-------------------------|--|
| Castings | ASTM A351 | CK3MCuN (UNS J93254) | | ASTM A351 S5, S6, ASTM A703 S20 ASTM A985 S20 |
| | ASTM A351 | CN3MN (UNS J94651) | | ASTM A351 S5, S6, ASTM A703 S20 ASTM A985 S20 |

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Repair of Defects

Repairs as described in A351 section 10.2 shall be considered major. All major repairs shall be documented in accordance with A703 S20.2 or A985 S20, as applicable.

The repair welding procedure shall be qualified in accordance with ASTM A488 or ISO 11970 and the following requirements:

- Welding procedure shall be qualified on the same cast material grade (UNS number) as used in production.
- Welding shall be carried out with Ni-based consumable with enhanced Mo or Cr content compared to the base material; the S content of the consumable shall not exceed 0.015 %.
- Change of specific make of filler metal (brand names) requires requalification for SMAW and FCAW processes.
- Corrosion test specimen shall include the weld zone.
- Testing methodology and acceptance criteria shall be in accordance with the requirements of this MDS for the parent material.

Examination of major repair welds on pressure containing parts shall also include RT.

Weld repairs are not acceptable for castings that leak during pressure testing.

Post weld heat treatment is required after all weld repairs.

If a minor cosmetic repair is required, heat treatment may be excluded providing the welding procedure meets all the specified microstructural, mechanical and corrosion material requirements of this data sheet in the as-welded condition.

Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^a

When sour service requirements are specified by the purchaser, the material shall conform to the requirements of ISO 15156 /NACE MR0175 or ISO 17945 /NACE MR0103, and this MDS:

Hardness testing

Production hardness testing shall be performed in accordance with the requirements in ASTM A370/A1058 on the pilot casting and one casting per lot thereafter for CK3MCuN castings. The maximum hardness shall be 100HRB (22HRC) from three readings taken in close proximity.

For other alloys the maximum hardness shall not exceed 35HRC.

The material shall be traceable in accordance with ISO 15156-3 /NACE MR0175-3 section 7.2 and this MDS.

Surface Treatment and Finish

Finished castings shall be pickled. Machined surfaces do not require pickling

Marking

The castings shall be marked to ensure full traceability to heat and heat treatment load.

Certification

The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser.

The inspection documents shall be in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification.

The inspection documents shall include the following information:

- MPS identification or MCPR/QTR number used;
- Steel manufacturer;
- Solution annealing temperature, holding time and quench medium shall be stated.

^a The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

Material Data Sheet **MDS No. IR117 / IR117S^a** **Rev. 01**

TYPE OF MATERIAL: Austenitic Stainless Steel, Type 6Mo

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|---------------------|-----------------|------------------|-------------------------|----------------------------------|
| Bars | ASTM A276 | UNS S31254 | | |
| | ASTM A276 | UNS N08367 | | |
| | ASTM A276 | UNS N08926 | | |
| | ASTM A479 | UNS S31254 | | |
| | ASTM A479 | UNS N08367 | | |
| | ASTM A479 | UNS N08926 | | |
| | ASTM A182 | F44 (UNS S31254) | | |
| | ASTM A182 | F62 (UNS N08367) | | |

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|-----------------------------|--|
| Scope | <p>This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification.</p> <p>This MDS includes additional requirements for valve parts DN 100 (NPS 4) and under manufactured from bars, when permitted by the valve specification.</p> <p>Product covered by this MDS is limited to a maximum thickness of 200 mm (8 in). For thickness exceeding 200 mm (8 in), qualification and specification requirements shall be subject to agreement.</p> |
| Qualification | Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or NORSOK M-650. The qualification testing shall meet the requirements of this MDS. |
| Metal Making | The melt shall be refined by AOD or equivalent method. |
| Manufacturing | <p>Bars shall be hot or cold finished cylindrical shaped with maximum diameter of 200 mm (8 in).</p> <p>NOTE Cold finishing shall be restricted to turning, grinding or polishing (singly or in combination); cold drawing or cold forming is not permitted.</p> |
| Chemical Composition | PREN ≥ 40.0 |
| Tensile Testing | Where tensile testing in both directions is required by this MDS, all tensile tests shall meet the specified properties of the referenced standard specification in both directions. |
| Corrosion testing | <p>Corrosion test according to ASTM G48 Method A is required. Test temperature shall be 50 °C (122 °F) and the exposure time 24 h. The test shall expose the external and internal surfaces and a cross section surface in full wall thickness. Cut edges shall be prepared according to ASTM G48. The complete specimen shall be pickled before being weighed and tested. Pickling may be performed for 5 min at 60 °C (140 °F) in a solution of 20 % HNO₃ + 5 % HF.</p> <p>The acceptance criteria are:</p> <ul style="list-style-type: none"> - No pitting at 20x magnification; - The weight loss shall be less than 4.0 g/m². |
| Extent of Testing | Tensile and corrosion tests shall be carried out for each lot as defined in ASTM A484. |
| Test Sampling | <p>The mid-length of axial (longitudinal) and tangential (transverse) tensile specimens shall be located at a distance equal to the bar outside diameter or minimum of 100 mm (4 in), whichever is the greater, from the end of the bar.</p> <p>The centreline of tensile specimen shall be located at a distance from the bar OD in accordance with ASTM A370 Annex A.</p> <p><u>Valve parts manufactured from bar</u></p> <p>For bars with outside diameter ≥ 100 mm (4 in) intended for machining of valve parts, tensile testing shall be taken in both the longitudinal and transverse direction.</p> |

Material Data Sheet **MDS No. IR117 / IR117S^a** **Rev. 01**

TYPE OF MATERIAL: *Austenitic Stainless Steel, Type 6Mo*

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|---------------------|-----------------|------------------|-------------------------|----------------------------------|
| Bars | ASTM A276 | UNS S31254 | | |
| | ASTM A276 | UNS N08367 | | |
| | ASTM A276 | UNS N08926 | | |
| | ASTM A479 | UNS S31254 | | |
| | ASTM A479 | UNS N08367 | | |
| | ASTM A479 | UNS N08926 | | |
| | ASTM A182 | F44 (UNS S31254) | | |
| | ASTM A182 | F62 (UNS N08367) | | |

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| Non-Destructive Testing | <u>Visual inspection</u> VT shall be carried out on each bar in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be cleaned prior to the testing. | | | | | | | | | | |
|--|--|---|---|------------------------|------|--------|-----------------------------|---------------------|-------|---------------------|---|
| | <u>NDT valve parts manufactured from bar</u> Inspection of valve parts manufactured from bar shall be according to the applicable valve specification. If a QSL is not specified by the purchaser, the requirements in this MDS shall apply including liquid penetrant testing according to the following table. | | | | | | | | | | |
| | <table border="1"> <thead> <tr> <th>NDE Requirement</th> <th>Part manufactured from bar^a</th> </tr> </thead> <tbody> <tr> <td>Frequency^b</td> <td>10 %</td> </tr> <tr> <td>Method</td> <td>ASME BPVC Sec. V, Article 6</td> </tr> <tr> <td>Extent^c</td> <td>100 %</td> </tr> <tr> <td>Acceptance criteria</td> <td>ASME BPVC Sec. VIII, Div. 1, Appendix 8</td> </tr> </tbody> </table> | NDE Requirement | Part manufactured from bar^a | Frequency ^b | 10 % | Method | ASME BPVC Sec. V, Article 6 | Extent ^c | 100 % | Acceptance criteria | ASME BPVC Sec. VIII, Div. 1, Appendix 8 |
| | NDE Requirement | Part manufactured from bar^a | | | | | | | | | |
| | Frequency ^b | 10 % | | | | | | | | | |
| | Method | ASME BPVC Sec. V, Article 6 | | | | | | | | | |
| Extent ^c | 100 % | | | | | | | | | | |
| Acceptance criteria | ASME BPVC Sec. VIII, Div. 1, Appendix 8 | | | | | | | | | | |
| NOTE The testing shall be carried out after machining, if applicable. Non-machined surfaces shall be pickled prior to the testing. | | | | | | | | | | | |
| ^a Part of size DN > 50 (NPS > 2). ^b For random examination (10 %), a minimum of one item per lot in any purchase order shall be examined. The test lot shall be as defined for mechanical testing. ^c All accessible internal and external surfaces shall be examined. | | | | | | | | | | | |

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| Repair of Defects | Weld repair is not permitted. |
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| Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^a | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of ISO 15156 /NACE MR0175 or ISO 17945 /NACE MR0103, and this MDS: |
| | <u>Hardness testing</u> Production hardness testing shall be performed in accordance with the requirements in ASTM A370/A1058 on the end surface of one bar per lot. The maximum hardness shall be 35HRC from three readings taken in close proximity. The material shall be traceable in accordance with ISO 15156-3 /NACE MR0175-3 section 7.2 and this MDS. |

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| Surface Treatment and Finish | Finished product shall be white pickled. |
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| Marking | The bars shall be marked to ensure full traceability to heat and heat treatment lot. |
|----------------|--|

| Material Data Sheet | | | | |
|---|--|------------------|------------------|---------------------------|
| MDS No. IR117 / IR117S ^a | | | Rev. 01 | |
| TYPE OF MATERIAL: Austenitic Stainless Steel, Type 6Mo | | | | |
| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
| Bars | ASTM A276 | UNS S31254 | | |
| | ASTM A276 | UNS N08367 | | |
| | ASTM A276 | UNS N08926 | | |
| | ASTM A479 | UNS S31254 | | |
| | ASTM A479 | UNS N08367 | | |
| | ASTM A479 | UNS N08926 | | |
| | ASTM A182 | F44 (UNS S31254) | | |
| | ASTM A182 | F62 (UNS N08367) | | |
| Page 3 of 3 | | | | |
| Certification | <p>The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser.</p> <p>The inspection documents shall be in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification.</p> <p>The inspection documents shall include the following information:</p> <ul style="list-style-type: none"> - MPS identification or MCPR/QTR number used; - Steel manufacturer; - Solution annealing temperature, holding time and quench medium shall be stated. | | | |
| ^a The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service. | | | | |

Material Data Sheet **MDS No. IR118 / IR118S^a** **Rev. 01**

| TYPE OF MATERIAL: Austenitic Stainless Steel, Type 6Mo | | | | |
|---|---|--------------|-------------------------|----------------------------------|
| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
| Tubes | ASTM A269 | UNS S31254 | | |
| | ASTM A269 | UNS N08367 | | |
| | ASTM A269 | UNS N08926 | | |
| Page 1 of 2 | | | | |
| Scope | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| Qualification | Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or NORSOK M-650. The qualification testing shall meet the requirements of this MDS. | | | |
| Metal Making | The melt shall be refined by AOD or equivalent method. | | | |
| Chemical Composition | PREN ≥ 40.0 | | | |
| Heat Treatment | The tubes shall be solution annealed followed by rapid cooling. Tubes shall be placed in such a way as to ensure free circulation of air and quenching medium around each tube during the heat treatment process including cooling. | | | |
| Tensile Testing | The following acceptance criteria shall apply. - UNS S31254: Rp _{0.2} ≥ 310 MPa (45 ksi); R _m ≥ 675 MPa (98 ksi); A ≥ 35 % - UNS N08367 Rp _{0.2} ≥ 310 MPa (45 ksi); R _m ≥ 690 MPa (100 ksi); A ≥ 35 % - UNS N08926 Rp _{0.2} ≥ 300 MPa (44 ksi); R _m ≥ 650 MPa (94 ksi); A ≥ 35 % | | | |
| Corrosion testing | Corrosion test according to ASTM G48 Method A is required. Test temperature shall be 50 °C (122 °F) and the exposure time 24 h. The test shall expose the external and internal surfaces and a cross section surface including weld zone in full wall thickness. Cut edges shall be prepared according to ASTM G48. The complete specimen shall be pickled before being weighed and tested. Pickling may be performed for 5 min at 60 °C (140 °F) in a solution of 20 % HNO ₃ + 5 % HF. The acceptance criteria are: - No pitting at 20x magnification; - The weight loss shall be less than 4.0 g/m ² . | | | |
| Extent of Testing | One tensile test, one corrosion test shall be carried out for each lot as defined in the standard for mechanical tests. | | | |
| Repair of Defects | Weld repair is not permitted. | | | |
| Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^a | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of ISO 15156 /NACE MR0175 or ISO 17945 /NACE MR0103, and this MDS: | | | |
| | <u>Hardness testing</u> Production hardness testing shall be performed in accordance with the requirements in ASTM A269. | | | |
| | The material shall be traceable in accordance with ISO 15156-3 /NACE MR0175-3 section 7.2 and this MDS. | | | |
| Surface Treatment and Finish | Finished product shall be white pickled or bright annealed. | | | |
| Marking | The tubes shall be marked to ensure full traceability to heat and heat treatment lot. | | | |

| Material Data Sheet | | MDS No. IR118 / IR118S ^a | | Rev. 01 |
|--|--|-------------------------------------|-------------------------|----------------------------------|
| TYPE OF MATERIAL: Austenitic Stainless Steel, Type 6Mo | | | | |
| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
| Tubes | ASTM A269 | UNS S31254 | | |
| | ASTM A269 | UNS N08367 | | |
| | ASTM A269 | UNS N08926 | | |
| Page 2 of 2 | | | | |
| Certification | <p>The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser.</p> <p>The inspection documents shall be in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification.</p> <p>The inspection documents shall include the following information:</p> <ul style="list-style-type: none"> - MPS identification or MCPR/QTR number used; - Steel manufacturer; - Solution annealing temperature, holding time and quench medium shall be stated. | | | |
| <p>^a The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.</p> | | | | |

Material Data Sheet**MDS No. IR119 / IR119S^a****Rev. 01**

TYPE OF MATERIAL: Austenitic Stainless Steel, Type 6Mo

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|--------------|-----------|------------|------------------|---------------------------|
| HIP Products | ASTM A988 | UNS S31254 | | ASTM A988 S5 |
| | ASTM A988 | UNS N08367 | | ASTM A988 S5 |

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Scope
 This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification.
 Product covered by this MDS is limited to a maximum thickness of 200 mm (8 in). For thickness exceeding 200 mm (8 in), qualification and specification requirements shall be subject to agreement.

Qualification
 Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or NORSOK M-650. The qualification testing shall meet the requirements of this MDS.

Manufacturing
 Gas atomized powder made from AOD-refined metal. Powder blends shall be a homogenous mixture of powder heats in terms of composition, particle size and other properties.

Chemical Composition
 PREN ≥ 40.0

Heat Treatment
 HIP product shall be solution annealed followed by water/liquid quenching.
 Products shall be placed in such a way as to ensure free circulation of heating and cooling media around each fitting during the heat treatment process including quenching.

Corrosion testing
 Corrosion test according to ASTM G48 Method A is required. Test temperature shall be 50 °C (122 °F) and the exposure time 24 h. The test shall expose the external and internal surfaces and a cross section surface in full wall thickness. Cut edges shall be prepared according to ASTM G48. The complete specimen shall be pickled before being weighed and tested. Pickling may be performed for 5 min at 60 °C (140 °F) in a solution of 20 % HNO₃ + 5 % HF.
 The acceptance criteria are:
 - No pitting at 20x magnification;
 - The weight loss shall be less than 4.0 g/m².

Extent of Testing
 One tensile and corrosion test shall be carried out for each lot as defined below.
 A lot shall consist of finished parts with the same dimensions made from the same powder blend consolidated in the same hot isostatic press using the same parameters and heat-treated in the same final heat-treatment load.

Non-Destructive Testing
Visual inspection
 VT shall be carried out on each item in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be pickled prior to the testing.
Liquid penetrant testing
 ASTM A988 supplementary requirement S5 shall apply as amended by this MDS:

| NDE Requirement | HIP product ^a |
|------------------------|---|
| Frequency ^b | 10 % |
| Method | ASME BPVC Sec. V, Article 6 |
| Extent ^c | 100 % |
| Acceptance criteria | ASME BPVC Sec. VIII, Div. 1, Appendix 8 |

NOTE The testing shall be carried out after machining, if applicable. Non-machined surfaces shall be pickled prior to the testing.
^a Parts of size DN > 50 (NPS > 2).
^b For random examination (10 %), a minimum of one item per lot in any purchase order shall be examined. The test lot shall be as defined for mechanical testing.
^c All accessible internal and external surfaces shall be examined.

Repair of Defects
 Weld repair is not permitted.

Material Data Sheet**MDS No. IR119 / IR119S^a****Rev. 01**

TYPE OF MATERIAL: Austenitic Stainless Steel, Type 6Mo

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|--------------|-----------|------------|------------------|---------------------------|
| HIP Products | ASTM A988 | UNS S31254 | | ASTM A988 S5 |
| | ASTM A988 | UNS N08367 | | ASTM A988 S5 |

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|---|---|
| Sour Service (additional metallurgical, manufacturing, testing and certification requirements) | <p>When sour service requirements are specified by the purchaser, the material shall conform to the requirements of ISO 15156 /NACE MR0175 or ISO 17945 /NACE MR0103, and the following additional requirements to the MDS:</p> <p><u>Hardness testing</u></p> <p>Production hardness testing shall be performed in accordance with the requirements in ASTM A370/A1058 on two parts per lot. When only one part is produced, it shall be hardness tested as required. The maximum hardness shall be 35HRC from three readings taken in close proximity.</p> <p>The material shall be traceable in accordance with ISO 15156-3 /NACE MR0175-3 section 7.2 and this MDS.</p> |
| Surface Treatment and Finish | Finished components shall be pickled. Machined surfaces do not require pickling. |
| Marking | The powder blend shall have a unique identity marked on the powder container and this identity shall be recorded and maintained throughout production of the product. The components shall be marked to ensure full traceability to heat and heat treatment lot. |
| Certification | <p>The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser.</p> <p>The inspection documents shall be in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification.</p> <p>The inspection documents shall include the following information:</p> <ul style="list-style-type: none"> - MPS identification or MCPR/QTR number used; - Manufacturer of the starting material (powder) for the finished product; - Solution annealing temperature, holding time and quench medium shall be stated. |

^a The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| Material Data Sheet | | | | |
|--|---|-------|------------------|---------------------------|
| MDS No. IS101 / IS101S ^a | | | Rev. 01 | |
| TYPE OF MATERIAL: Austenitic Stainless Steel, Type 316 | | | | |
| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
| Seamless pipes | ASTM A312 | TP316 | | |
| Page 1 of 1 | | | | |
| Scope | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| Chemical Composition | The chemical composition shall comply with UNS S31603 (dual certified 316/316L). | | | |
| Repair of Defects | Weld repair is not permitted. | | | |
| Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^a | <p>When sour service requirements are specified by the purchaser, the material shall conform to the requirements of ISO 15156 /NACE MR0175 or ISO 17945 /NACE MR0103, and the following additional requirements to the MDS:</p> <p><u>Hardness testing</u></p> <p>Production hardness testing shall be performed in accordance with the requirements in ASTM A370/A1058 on one length of pipe per lot. The maximum hardness shall be 22HRC from three readings taken in close proximity.</p> <p>The material shall be traceable in accordance with ISO 15156-3 /NACE MR0175-3 section 7.2 and this MDS.</p> | | | |
| Surface Treatment and Finish | Finished pipes shall be pickled or bright annealed. Machined surfaces do not require pickling. | | | |
| Marking | The pipes shall be marked to ensure full traceability to heat and heat treatment lot. | | | |
| Certification | <p>The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser.</p> <p>The inspection documents shall be in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification.</p> <p>The inspection documents shall include the following information:</p> <ul style="list-style-type: none"> - Heat treatment conditions; - The inspection documents shall confirm compliance to both UNS S31603 and S31600. | | | |
| <p>^a The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.</p> | | | | |

Material Data Sheet**MDS No. IS102 / IS102S^a****Rev. 01**

TYPE OF MATERIAL: Austenitic Stainless Steel, Type 316

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|--------------|-----------|-------|--------------------|---------------------------|
| Welded pipes | ASTM A312 | TP316 | | |
| | ASTM A358 | 316 | Class 1, 3, 4 or 5 | |

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Scope
This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification.

Chemical Composition
The chemical composition shall comply with UNS S31603 (dual certified 316/316L).

Repair of Defects
Weld repair of base material is not permitted.
For repair of welds, the requirements for production welding above shall apply to the repair WPS. Repair welds shall be heat treated as per original production weld.

Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^a
When sour service requirements are specified by the purchaser, the material shall conform to the requirements of ISO 15156 /NACE MR0175 or ISO 17945 /NACE MR0103, and the following additional requirements to the MDS:

Hardness testing

- Welding procedure qualification testing for manufacturing and any repair welding shall meet the requirements of NACE MR0175-2 /ISO 15156-3 section 6.2.2, with a maximum hardness of 70.8HR 15N or 250HV.
- Production hardness testing shall be performed on one length of pipe per lot. The maximum hardness of the base material, HAZ and weld metal shall be 22HRC from three readings taken in close proximity at each location.

The material shall be traceable in accordance with ISO 15156-3 /NACE MR0175-3 section 7.2 and this MDS.

Surface Treatment and Finish
Finished pipes shall be pickled or bright annealed. Machined surfaces do not require pickling.

Marking
The pipes shall be marked to ensure full traceability to heat and heat treatment lot.

Certification
The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser.
The inspection documents shall be in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification.
The inspection documents shall include the following information:

- Heat treatment conditions;
- The inspection documents shall confirm compliance to both UNS S31603 and S31600.

^a The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

Material Data Sheet **MDS No. IS103 / IS103S^a** **Rev. 01**

TYPE OF MATERIAL: Austenitic Stainless Steel, Type 316

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|---------------------|-----------------|--------------|-------------------------|----------------------------------|
| Wrought fittings | ASTM A403 | WP316 | W or S or WX | |

Page 1 of 1

Scope This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification.

Chemical Composition The chemical composition shall comply with UNS S31603 (dual certified 316/316L).

Heat Treatment During heat treatment fittings shall be placed in such a way as to ensure free circulation around each fittings during the heat treatment process including possible quenching operation.

Non-Destructive Testing Ultrasonic testing is not acceptable as replacement for radiography.

Repair of Defects Weld repair of base material is not acceptable.
For repair of welds, the requirements for production welding above shall apply to the repair WPS. Repair welds shall be heat treated as per original production weld.

Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^a When sour service requirements are specified by the purchaser, the material shall conform to the requirements of ISO 15156 /NACE MR0175 or ISO 17945 /NACE MR0103, and the following additional requirements to the MDS:

Hardness testing

- Seamless fittings:
 - Production testing shall be performed in accordance with the requirements in ASTM A370/A1058 on one fitting per lot. The maximum hardness shall be 22HRC from three readings taken in close proximity.
- Welded fittings:
 - Welding procedure qualification testing for manufacturing and any repair welding shall meet the requirements of NACE MR0175-3 /ISO 15156-3 section 6.2.2 with a maximum hardness of 70.8HR 15N or 250HV.
 - Production testing shall be performed in accordance with the requirements in ASTM A370/A1058 on one fitting per lot. The maximum hardness of the base material, HAZ and weld metal shall be 22HRC from three readings taken in close proximity at each location.

The material shall be traceable in accordance with ISO 15156-3 /NACE MR0175-3 section 7.2 and this MDS.

Surface Treatment and Finish Finished fittings shall be pickled or bright annealed. Machined surfaces do not require pickling.

Marking The fittings shall be marked to ensure full traceability to heat and heat treatment lot.

Certification The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser.
The inspection documents shall be in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification.
The inspection documents shall include the following information:

- Heat treatment conditions;
- The inspection documents shall confirm compliance to both UNS S31603 and S31600.

^a The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| Material Data Sheet | | MDS No. IS104 / IS104S ^a | | Rev. 01 |
|--|---|-------------------------------------|-------------------------|----------------------------------|
| TYPE OF MATERIAL: Austenitic Stainless Steel, Type 316 | | | | |
| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
| Forgings | ASTM A182 | F316 | | |
| Page 1 of 1 | | | | |
| Scope | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| Chemical Composition | The chemical composition shall comply with F316L (dual certified F316/F316L). | | | |
| Heat Treatment | Forgings shall be supplied in the solution annealed conditions. Forgings shall be placed in such a way as to ensure free circulation around each forging during the heat treatment process including possible quenching operation. | | | |
| Non-Destructive Testing | <p><u>Visual Inspection</u> VT shall be carried out on each forging or bar in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be pickled prior to the testing.</p> <p><u>Valve forgings NDT</u> Inspection shall be according to the applicable valve specification. If a QSL is not specified by the purchaser, the requirements in this MDS shall apply.</p> | | | |
| Repair of Defects | Weld repair is not permitted. | | | |
| Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^a | <p>When sour service requirements are specified by the purchaser, the material shall conform to the requirements of ISO 15156 /NACE MR0175 or ISO 17945 /NACE MR0103, and the following additional requirements to the MDS:</p> <p><u>Hardness testing</u> Production hardness testing shall be performed in accordance with the requirements in ASTM A370/A1058 on one forging per lot. The maximum hardness shall be 22HRC from three readings taken in close proximity.</p> <p>The material shall be traceable in accordance with ISO 15156-3 /NACE MR0175-3 section 7.2 and this MDS.</p> | | | |
| Surface Treatment and Finish | Finished forgings shall be pickled or bright annealed. Machined surfaces do not require pickling. | | | |
| Marking | The forgings shall be marked to ensure full traceability to heat and heat treatment lot. | | | |
| Certification | <p>The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser.</p> <p>The inspection documents shall be in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification.</p> <p>The inspection documents shall include the following information:</p> <ul style="list-style-type: none"> - Heat treatment conditions; - The inspection documents shall confirm compliance to both F316 and F316L. | | | |
| <p>^a The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.</p> | | | | |

| Material Data Sheet | | MDS No. IS105 / IS105S ^a | | Rev. 01 |
|--|--|-------------------------------------|------------------|---------------------------|
| TYPE OF MATERIAL: Austenitic Stainless Steel, Type 316 | | | | |
| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
| <i>Plates, sheets, strips</i> | ASTM A240 | 316 | | |
| Page 1 of 1 | | | | |
| Scope | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| Chemical Composition | The chemical composition shall comply with UNS S31603 (dual certified 316/316L). | | | |
| Non-Destructive Testing | <p><u>Visual Inspection</u></p> <p>VT shall be carried out on each plate in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be cleaned prior to the testing.</p> <hr/> <p><u>Valve plates NDT</u></p> <p>Inspection of plates for valve parts shall be according to the applicable valve specification. If a QSL is not specified by the purchaser, the requirements in this MDS shall apply.</p> | | | |
| Repair of Defects | Weld repair is not permitted. | | | |
| Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^a | <p>When sour service requirements are specified by the purchaser, the material shall conform to the requirements of ISO 15156 /NACE MR0175 or ISO 17945 /NACE MR0103, and the following additional requirements to the MDS:</p> <hr/> <p><u>Hardness testing</u></p> <p>Production hardness testing shall be performed in accordance with the requirements in ASTM A370/A1058 on one plate per lot. The maximum hardness shall be 22HRC from three readings taken in close proximity.</p> <hr/> <p>The material shall be traceable in accordance with ISO 15156- 3/NACE MR0175-3 section 7.2 and this MDS.</p> | | | |
| Surface Treatment and Finish | According to the requirements in ASTM A480. | | | |
| Marking | The plates, sheets and strips shall be marked to ensure full traceability to heat and heat treatment lot. | | | |
| Certification | <p>The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser.</p> <p>The inspection documents shall be in accordance with ISO 10474 /EN 10204 Type 3.1.</p> <p>The inspection documents shall confirm compliance with this specification and shall include the following information:</p> <ul style="list-style-type: none"> - Heat treatment conditions; - The inspection documents shall confirm compliance to both UNS S31603 and S31600. | | | |
| <p>^a The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.</p> | | | | |

Material Data Sheet **MDS No. IS106 / IS106S^a** **Rev. 01**

TYPE OF MATERIAL: *Austenitic Stainless Steel, Type 316*

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|--------------|-----------|-------|------------------|---------------------------------|
| Castings | ASTM A351 | CF8M | | ASTM A351 S5, S6, ASTM A703 S20 |
| | ASTM A351 | CF3M | | ASTM A351 S5, S6, ASTM A703 S20 |

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| | |
|--------------------------|--|
| Scope | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. |
| Extent of Testing | Tensile testing is required for each heat and heat treatment lot including any PWHT. |
| Test Sampling | For castings with a weight of 250 kg (551 lb) or more, the test blocks shall be integrally cast or gated onto the casting and shall accompany the castings through all heat treatment operations. During any PWHT the test block shall be tack welded onto the casting. |

| | | | |
|---|--|---|---------------------------------------|
| Non-Destructive Testing | <u>Visual inspection</u> | | |
| | NDE requirement | Pilot casting (section 4.8) | Production casting |
| | Frequency | Each pilot casting | Each production casting |
| | Method | ANSI/MSS SP-55 | |
| | Extent | 100 % of all accessible surfaces including welding ends | |
| | Acceptance criteria | MSS SP-55 | |
| | NOTE The testing shall be carried out after machining, if applicable. Non-machined surfaces shall be pickled prior to the testing. | | |
| | <u>Liquid penetrant testing</u> | | |
| | ASTM A351 Supplementary requirement S6 shall apply as amended by this MDS: | | |
| | NDE Requirement | Pilot casting (section 4.8) | Production casting^a |
| Frequency ^b | 100 % | 100 % | |
| Method | ASME BPVC Sec. V, Article 6 | ASME BPVC Sec. V, Article 6 | |
| Extent ^c | 100 % | 100 % | |
| Acceptance criteria | ASME BPVC Sec. VIII, Div. 1, Appendix 7 | ASME BPVC Sec. VIII, Div. 1, Appendix 7 | |
| NOTE The testing shall be carried out after machining, if applicable. Non-machined surfaces shall be cleaned prior to the testing. | | | |
| ^a Production valve castings, PT shall be according to the applicable valve specification. If a QSL is not specified by the purchaser, the requirements in this table shall apply. ^b Frequency of inspection 100 % means that each item shall be examined. ^c All accessible internal and external surfaces shall be examined. | | | |

Material Data Sheet**MDS No. IS106 / IS106S^a****Rev. 01**

TYPE OF MATERIAL: Austenitic Stainless Steel, Type 316

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|--------------|-----------|-------|------------------|---------------------------------|
| Castings | ASTM A351 | CF8M | | ASTM A351 S5, S6, ASTM A703 S20 |
| | ASTM A351 | CF3M | | ASTM A351 S5, S6, ASTM A703 S20 |

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Radiographic testing
ASTM A351 supplementary requirement S5 shall apply as amended by this MDS:

| NDE requirement | Pilot casting (section 4.8) | Production casting | | | | Other pressure containing castings ^b | |
|--|--|-----------------------------|-------|----------------|--------------------|---|--------|
| | | Valve castings ^a | | | | | |
| Frequency ^c | 100 % | NPS | DN | Pressure class | | | |
| | | | | ≤ 300 | 600 | 900 | ≥ 1500 |
| | | < 2 | < 50 | N/R | N/R | N/R | N/R |
| | | ≥ 2 | ≥ 50 | N/R | 5 % | 5 % | 5 % |
| | | ≥ 6 | ≥ 150 | N/R | 5 % | 5 % | 100 % |
| | | ≥ 10 | ≥ 250 | 5 % | 5 % | 5 % | 100 % |
| | | ≥ 16 | ≥ 400 | 5 % | 5 % | 100 % | 100 % |
| ≥ 20 | ≥ 500 | 5 % | 100 % | 100 % | 100 % | | |
| Method | ASME BPVC Sec. V, Article 2 | | | | | | |
| Extent | Areas defined by ASME B16.34 for special class valves, at abrupt changes in sections and at the junctions of risers, gates or feeders to the casting | | | | 100 % ^d | | |
| Acceptance criteria | ASME BPVC Sec. VIII, Div. 1, Appendix 7 | | | | | | |
| <p>NOTE N/R means not required, unless specified otherwise by the purchaser.</p> <p>^a Production valve casting, RT shall be according to the applicable valve specification. If a QSL is not specified by the purchaser, the requirements in this table shall apply.</p> <p>^b Production casting other than valve casting.</p> <p>^c Frequency of inspection 100 % means that each item shall be examined. When random examination (5 %) is specified, a minimum of one item per lot of each pattern in any purchase order shall be examined.</p> <p>^d Production casting other than valve casting, inspection shall include other critical areas as defined in the purchase order and/or applicable product specification or standard. Sketches of the areas to be tested shall be established and agreed with the purchaser.</p> | | | | | | | |

Repair of Defects

Repairs as described in A351 section 10.2 shall be considered major. All major repairs shall be documented in accordance with A703 S20.2.

The repair welding procedure shall be qualified in accordance with ASTM A488 or ISO 11970 and this MDS:

- Welding procedure shall be qualified on casting or plate of the same cast material grade as used in production;
- Testing methodology and acceptance criteria shall be in accordance with the requirements of this MDS for the parent material.

Weld repairs are not acceptable for castings that leak during pressure testing.

Solution annealing heat treatment is required after all major weld repairs.

If a minor cosmetic repair is required to a semi-finished or finished cast component, heat treatment may be omitted provided the welding procedure meets all the test requirements of this data sheet in the as-welded condition.

Material Data Sheet **MDS No. IS106 / IS106S^a** **Rev. 01**

TYPE OF MATERIAL: Austenitic Stainless Steel, Type 316

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|---------------------|-----------------|--------------|-------------------------|----------------------------------|
| Castings | ASTM A351 | CF8M | | ASTM A351 S5, S6, ASTM A703 S20 |
| | ASTM A351 | CF3M | | ASTM A351 S5, S6, ASTM A703 S20 |

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|---|---|
| Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^a | <p>When sour service requirements are specified by the purchaser, the material shall conform to the requirements of ISO 15156 /NACE MR0175 or ISO 17945 /NACE MR0103, and this MDS:</p> <p><u>Hardness testing</u></p> <ul style="list-style-type: none"> - Production hardness testing shall be performed in accordance with the requirements in ASTM A370/A1058 on the pilot casting and one casting per lot thereafter. The maximum hardness shall be 22HRC from three readings taken in close proximity. - Welding procedure qualification testing for all repair welding on shall meet the requirements of NACE MR0175-2 /ISO 15156-3 section 6.2.6 with a maximum hardness of 70.8HR 15N or 250HV. <p>The material shall be traceable in accordance with ISO 15156-3 /NACE MR0175-3 section 7.2 and this MDS.</p> |
| Surface Treatment and Finish | Finished castings shall be pickled. Machined surfaces do not require pickling. |
| Marking | The castings shall be marked to ensure full traceability to heat and heat treatment lot. |
| Certification | <p>The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser.</p> <p>The inspection documents shall be in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification.</p> <p>The inspection documents shall include the following information:</p> <ul style="list-style-type: none"> - Heat treatment conditions. |

^a The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| Material Data Sheet | | | | | MDS No. IS107 / IS107S ^a | | Rev. 01 | |
|---|--|-------|------------------|---------------------------|-------------------------------------|--|---------|--|
| TYPE OF MATERIAL: Austenitic Stainless Steel, Type 316 | | | | | | | | |
| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT | | | | |
| Bars | ASTM A276 | 316 | | | | | | |
| | ASTM A479 | 316 | | | | | | |
| Page 1 of 2 | | | | | | | | |
| Scope | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | | | | | |
| Manufacturing | Bars shall be hot or cold finished cylindrical shaped with maximum diameter of 300 mm (12 in). NOTE Cold finishing shall be restricted to turning, grinding or polishing (singly or in combination); cold drawing or cold forming is not permitted. | | | | | | | |
| Chemical Composition | The chemical composition shall comply with UNS S31603 (dual certified 316/316L). | | | | | | | |
| Heat Treatment | Bars shall be supplied in the solution annealing conditions. Bars shall be placed in such a way as to ensure free circulation around each component during the heat treatment process including possible quenching operation. | | | | | | | |
| Tensile Testing | Where tensile testing in both directions is required by this MDS, all tensile tests shall meet the specified properties of the referenced standard specification in both directions. | | | | | | | |
| Test Sampling | The mid-length of axial (longitudinal) and tangential (transverse) tensile specimens shall be located at a distance equal to the bar outside diameter or minimum of 100 mm (4 in), whichever is the greater, from the end of the bar. The centreline of tensile specimen shall be located at a distance from the bar surface in accordance with ASTM A370 Annex A. <u>Valve parts manufactured from bar</u> For bars with outside diameter ≥ 100 mm intended for machining of valve parts, tensile testing shall be taken in both the longitudinal and transverse direction. | | | | | | | |
| Non-Destructive Testing | <u>Visual Inspection</u> VT shall be carried out on each bar in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be cleaned prior to the testing. <u>NDT valve parts manufactured from bar</u> Inspection of valve parts manufactured from bar shall be according to the applicable valve specification. If a QSL is not specified by the purchaser, the requirements in this MDS shall apply. | | | | | | | |
| Repair of Defects | Weld repair is not permitted. | | | | | | | |
| Sour Service (additional metallurgical, manufacturing, testing and certification requirements) | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of ISO 15156 /NACE MR0175 or ISO 17945 /NACE MR0103, and the following additional requirements to the MDS: <u>Hardness testing</u> Production hardness testing shall be performed in accordance with the requirements in ASTM A370/A1058 on the end surface of one bar per lot. The maximum hardness shall be 22HRC from three readings taken in close proximity. The material shall be traceable in accordance with ISO 15156-3 /NACE MR0175-3 section 7.2 and this MDS. | | | | | | | |
| Surface Treatment and Finish | Finished bars shall be pickled or bright annealed. Machined surfaces do not require pickling. | | | | | | | |
| Marking | The bars shall be marked to ensure full traceability to heat and heat treatment lot. | | | | | | | |

Material Data Sheet **MDS No. IS107 / IS107S^a** **Rev. 01**

TYPE OF MATERIAL: Austenitic Stainless Steel, Type 316

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|---------------------|-----------------|--------------|-------------------------|----------------------------------|
| Bars | ASTM A276 | 316 | | |
| | ASTM A479 | 316 | | |

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| | |
|----------------------|---|
| Certification | <p>The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser.</p> <p>The inspection documents shall be in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification.</p> <p>The inspection documents shall include the following information:</p> <ul style="list-style-type: none"> - Heat treatment conditions; - The inspection documents shall confirm compliance to both UNS S31603 and S31600. |
|----------------------|---|

^a The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

Material Data Sheet **MDS No. IS108 / IS108S^a** **Rev. 01**

TYPE OF MATERIAL: Austenitic Stainless Steel, Type 316

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|---------------------|-----------------|--------------|-------------------------|----------------------------------|
| Tubes | ASTM A269 | 316 | | |

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| | |
|---|---|
| Scope | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. |
| Chemical Composition | The chemical composition shall comply with UNS S31603 (dual certified 316/316L). |
| Tensile Testing | The following acceptance criteria shall apply: $R_{p0.2} \geq 207$ MPa (30 ksi); $R_m \geq 517$ MPa (75 ksi); $A \geq 35$ % |
| Extent of Testing | Tensile testing shall be carried out for each lot as defined in the standard for mechanical tests. |
| Non-Destructive Testing | Welded tubes: non-destructive electric testing is required. |
| Repair of Defects | Weld repair of base material is not permitted. For repair of welds, the requirements for production welding above shall apply to the repair WPS. Repair welds shall be heat treated as per original production weld |
| Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^a | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of ISO 15156 /NACE MR0175 or ISO 17945 /NACE MR0103, and the following additional requirements to the MDS: <u>Hardness testing</u> Production hardness testing shall be performed in accordance with the requirements in ASTM A269. The material shall be traceable in accordance with ISO 15156-3 /NACE MR0175-3 section 7.2 and this MDS. |
| Surface Treatment and Finish | Finished tubes shall be pickled or bright annealed. |
| Marking | The tubes shall be marked to ensure full traceability to heat and heat treatment lot. |
| Certification | The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser. The inspection documents shall be in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification. The inspection documents shall include the following information: - Heat treatment conditions; - The inspection documents shall confirm compliance to both UNS S31603 and S31600. |

^a The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| Material Data Sheet | | | | | MDS No. IS221 / IS221S ^a | | Rev. 01 | |
|---|---|--------------|-------------------------|----------------------------------|-------------------------------------|--|---------|--|
| TYPE OF MATERIAL: Austenitic Stainless Steel, Type 304 | | | | | | | | |
| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT | | | | |
| Seamless pipes | ASTM A312 | TP304 | | | | | | |
| Page 1 of 1 | | | | | | | | |
| Scope | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | | | | | |
| Chemical Composition | The chemical composition shall comply with UNS S30403 (dual certified 304/304L). | | | | | | | |
| Repair of Defects | Weld repair is not permitted. | | | | | | | |
| Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^a | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of ISO 15156 /NACE MR0175 or ISO 17945 /NACE MR0103, and the following additional requirements to the MDS: | | | | | | | |
| | <u>Hardness testing</u> | | | | | | | |
| | Production hardness testing shall be performed in accordance with the requirements in ASTM A370/A1058 on one length of pipe per lot. The maximum hardness shall be 22HRC from three readings taken in close proximity. | | | | | | | |
| | The material shall be traceable in accordance with ISO 15156-3 /NACE MR0175-3 section 7.2 and this MDS. | | | | | | | |
| Surface Treatment and Finish | Finished pipes shall be pickled or bright annealed. Machined surfaces do not require pickling. | | | | | | | |
| Marking | The pipes shall be marked to ensure full traceability to heat and heat treatment lot. | | | | | | | |
| Certification | <p>The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser.</p> <p>The inspection documents shall be in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification.</p> <p>The inspection documents shall include the following information:</p> <ul style="list-style-type: none"> - Heat treatment conditions; - The inspection documents shall confirm compliance to both UNS S30403 and S30400. | | | | | | | |
| ^a The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service. | | | | | | | | |

| Material Data Sheet | | | | |
|---|--|-------|--------------------|---------------------------|
| MDS No. IS222 / IS222S ^a | | | Rev. 01 | |
| TYPE OF MATERIAL: Austenitic Stainless Steel, Type 304 | | | | |
| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
| Welded pipes | ASTM A312 | TP304 | | |
| | ASTM A358 | 304 | Class 1, 3, 4 or 5 | |
| Page 1 of 1 | | | | |
| Scope | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| Chemical Composition | The chemical composition shall comply with UNS S30403 (dual certified 304/304L). | | | |
| Repair of Defects | Weld repair of base material is not permitted. For repair of welds, the requirements for production welding above shall apply to the repair WPS. Repair welds shall be heat treated as per original production weld. | | | |
| Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^a | <p>When sour service requirements are specified by the purchaser, the material shall conform to the requirements of ISO 15156 /NACE MR0175 or ISO 17945 /NACE MR0103, and the following additional requirements to the MDS:</p> <p><u>Hardness testing</u></p> <ul style="list-style-type: none"> - Welding procedure qualification testing for manufacturing and any repair welding shall meet the requirements of NACE MR0175-2 /ISO 15156-3 section 6.2.2, with a maximum hardness of 70.8HR 15N or 250HV. - Production hardness testing shall be performed on one length of pipe per lot. The maximum hardness of the base material, HAZ and weld metal shall be 22HRC from three readings taken in close proximity at each location. <p>The material shall be traceable in accordance with ISO 15156-3 /NACE MR0175-3 section 7.2 and this MDS.</p> | | | |
| Surface Treatment and Finish | Finished pipes shall be pickled or bright annealed. Machined surfaces do not require pickling. | | | |
| Marking | The pipes shall be marked to ensure full traceability to heat and heat treatment lot. | | | |
| Certification | <p>The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser.</p> <p>The inspection documents shall be in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification.</p> <p>The inspection documents shall include the following information:</p> <ul style="list-style-type: none"> - Heat treatment conditions; - The inspection documents shall confirm compliance to both UNS S30403 and S30400. | | | |
| ^a The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service. | | | | |

Material Data Sheet **MDS No. IS223 / IS223S^a** **Rev. 01**

TYPE OF MATERIAL: Austenitic Stainless Steel, Type 304

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|---------------------|-----------------|--------------|-------------------------|----------------------------------|
| Wrought fittings | ASTM A403 | WP304 | W or S or WX | |

Page 1 of 1

Scope This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification.

Chemical Composition The chemical composition shall comply with UNS S30403 (dual certified 304/304L).

Heat Treatment During heat treatment fittings shall be placed in such a way as to ensure free circulation around each fitting during the heat treatment process including possible quenching operation.

Non-Destructive Testing Ultrasonic testing is not acceptable as replacement for radiography.

Repair of Defects Weld repair of base material is not acceptable.
For repair of welds, the requirements for production welding above shall apply to the repair WPS. Repair welds shall be heat treated as per original production weld.

Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^a When sour service requirements are specified by the purchaser, the material shall conform to the requirements of ISO 15156 /NACE MR0175 or ISO 17945 /NACE MR0103, and the following additional requirements to the MDS:

Hardness testing

- Seamless fittings:
 - Production testing shall be performed in accordance with the requirements in ASTM A370/A1058 on one fitting per lot. The maximum hardness shall be 22HRC from three readings taken in close proximity.
- Welded fittings:
 - Welding procedure qualification testing for manufacturing and any repair welding shall meet the requirements of NACE MR0175-3 /ISO 15156-3 section 6.2.2 with a maximum hardness of 70.8HR 15N or 250HV.
 - Production testing shall be performed in accordance with the requirements in ASTM A370/A1058 on one fitting per lot. The maximum hardness of the base material, HAZ and weld metal shall be 22HRC from three readings taken in close proximity at each location.

The material shall be traceable in accordance with ISO 15156-3 /NACE MR0175-3 section 7.2 and this MDS.

Surface Treatment and Finish Finished fittings shall be pickled or bright annealed. Machined surfaces do not require pickling.

Marking The fittings shall be marked to ensure full traceability to heat and heat treatment lot.

Certification The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser.
The inspection documents shall be in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification.
The inspection documents shall include the following information:

- Heat treatment conditions;
- The inspection documents shall confirm compliance to both UNS S30403 and S30400.

^a The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| Material Data Sheet | | MDS No. IS224 / IS224S ^a | | | Rev. 01 |
|---|---|-------------------------------------|------------------|---------------------------|---------|
| TYPE OF MATERIAL: Austenitic Stainless Steel, Type 304 | | | | | |
| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT | |
| Forgings | ASTM A182 | F304 | | | |
| Page 1 of 1 | | | | | |
| Scope | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | | |
| Chemical Composition | The chemical composition shall comply with F304L (dual certified F304/F304L). | | | | |
| Heat Treatment | Forgings shall be supplied in the solution annealed conditions. Forgings shall be placed in such a way as to ensure free circulation around each component during the heat treatment process including possible quenching operation. | | | | |
| Non-Destructive Testing | <p><u>Visual Inspection</u> VT shall be carried out on each forging or bar in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be pickled prior to the testing.</p> <p><u>Valve forgings NDT</u> Inspection shall be according to the applicable valve specification. If a QSL is not specified by the purchaser, the requirements in this MDS shall apply.</p> | | | | |
| Repair of Defects | Weld repair is not permitted. | | | | |
| Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^a | <p>When sour service requirements are specified by the purchaser, the material shall conform to the requirements of ISO 15156 /NACE MR0175 or ISO 17945 /NACE MR0103, and the following additional requirements to the MDS:</p> <p><u>Hardness testing</u> Production hardness testing shall be performed in accordance with the requirements in ASTM A370/A1058 on one forging per lot. The maximum hardness shall be 22HRC from three readings taken in close proximity.</p> <p>The material shall be traceable in accordance with ISO 15156-3 /NACE MR0175-3 section 7.2 and this MDS.</p> | | | | |
| Surface Treatment and Finish | Finished forgings shall be pickled or bright annealed. Machined surfaces do not require pickling. | | | | |
| Marking | The forgings shall be marked to ensure full traceability to heat and heat treatment lot. | | | | |
| Certification | <p>The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser.</p> <p>The inspection documents shall be in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification.</p> <p>The inspection documents shall include the following information:</p> <ul style="list-style-type: none"> - Heat treatment conditions; - The inspection documents shall confirm compliance to both F304 and F304L. | | | | |
| ^a The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service. | | | | | |

Material Data Sheet **MDS No. IS225 / IS225S^a** **Rev. 01**

TYPE OF MATERIAL: Austenitic Stainless Steel, Type 304

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|------------------------|-----------------|--------------|-------------------------|----------------------------------|
| Plates, sheets, strips | ASTM A240 | 304 | | |

Page 1 of 1

Scope This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification.

Chemical Composition The chemical composition shall comply with UNS S30403 (dual certified 304/304L).

Non-Destructive Testing

Visual Inspection
VT shall be carried out on each plate in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be cleaned prior to the testing.

Valve plate NDT
Inspection of plates for valve parts shall be according to the applicable valve specification. If a QSL is not specified by the purchaser, the requirements in this MDS shall apply.

Repair of Defects Weld repair is not permitted.

Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^a

When sour service requirements are specified by the purchaser, the material shall conform to the requirements of ISO 15156 /NACE MR0175 or ISO 17945 /NACE MR0103, and the following additional requirements to the MDS:

Hardness testing
Production hardness testing shall be performed in accordance with the requirements in ASTM A370/A1058 on one plate per lot. The maximum hardness shall be 22HRC from three readings taken in close proximity.

The material shall be traceable in accordance with ISO 15156-3 /NACE MR0175-3 section 7.2 and this MDS.

Surface Treatment and Finish According to the requirements in ASTM A480.

Marking The plates, sheets and strips shall be marked to ensure full traceability to heat and heat treatment lot.

Certification

The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser.

The inspection documents shall be in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification.

The inspection documents shall include the following information:

- Heat treatment conditions;
- The inspection documents shall confirm compliance to both UNS S30403 and S30400.

^a The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

Material Data Sheet **MDS No. IS226 / IS226S^a** **Rev. 01**

TYPE OF MATERIAL: *Austenitic Stainless Steel, Type 304*

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|---------------------|-----------------|--------------|-------------------------|----------------------------------|
| Castings | ASTM A351 | CF8 | | ASTM A351 S5, S6, ASTM A703 S20 |
| | ASTM A351 | CF3 | | ASTM A351 S5, S6, ASTM A703 S20 |

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Scope This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification.

Extent of Testing Tensile testing is required for each heat and heat treatment lot including any PWHT.

Test Sampling For castings with a weight of 250 kg (551 lb) or more, the test blocks shall be integrally cast or gated onto the casting and shall accompany the castings through all heat treatment operations. During any PWHT the test block shall be tack welded onto the casting.

Non-Destructive Testing

Visual inspection

| NDE requirement | Pilot casting (section 4.8) | Production casting |
|------------------------|---|---------------------------|
| Frequency | Each pilot casting | Each production casting |
| Method | ANSI/MSS SP-55 | |
| Extent | 100 % of all accessible surfaces including welding ends | |
| Acceptance criteria | MSS SP-55 | |

NOTE The testing shall be carried out after machining, if applicable. Non-machined surfaces shall be pickled prior to the testing.

Liquid penetrant testing

ASTM A351 Supplementary requirement S6 shall apply as amended by this MDS:

| NDE Requirement | Pilot casting (section 4.8) | Production casting^a |
|------------------------|---|---|
| Frequency ^b | 100 % | 100 % |
| Method | ASME BPVC Sec. V, Article 6 | ASME BPVC Sec. V, Article 6 |
| Extent ^c | 100 % | 100 % |
| Acceptance criteria | ASME BPVC Sec. VIII, Div. 1, Appendix 7 | ASME BPVC Sec. VIII, Div. 1, Appendix 7 |

NOTE The testing shall be carried out after machining, if applicable. Non-machined surfaces shall be cleaned prior to the testing.

^a Production valve castings, PT shall be according to the applicable valve specification. If a QSL is not specified by the purchaser, the requirements in this table shall apply.

^b Frequency of inspection 100 % means that each item shall be examined.

^c All accessible internal and external surfaces shall be examined.

Material Data Sheet **MDS No. IS226 / IS226S^a** **Rev. 01**

TYPE OF MATERIAL: Austenitic Stainless Steel, Type 304

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|--------------|-----------|-------|------------------|---------------------------------|
| Castings | ASTM A351 | CF8 | | ASTM A351 S5, S6, ASTM A703 S20 |
| | ASTM A351 | CF3 | | ASTM A351 S5, S6, ASTM A703 S20 |

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| <p><u>Radiographic testing</u> ASTM A351 supplementary requirement S5 shall apply as amended by this MDS:</p> | | | | | | | | |
|--|--|-----------------------------|-------|----------------|--------------------|---|-------|--------|
| NDE requirement | Pilot casting (section 4.8) | Production casting | | | | Other pressure containing castings ^b | | |
| | | Valve castings ^a | | | | | | |
| Frequency ^c | 100 % | NPS | DN | Pressure class | | 100 % | | |
| | | | | ≤ 300 | 600 | | 900 | ≥ 1500 |
| | | < 2 | < 50 | N/R | N/R | | N/R | N/R |
| | | ≥ 2 | ≥ 50 | N/R | 5 % | | 5 % | 5 % |
| | | ≥ 6 | ≥ 150 | N/R | 5 % | | 5 % | 100 % |
| | | ≥ 10 | ≥ 250 | 5 % | 5 % | | 5 % | 100 % |
| | | ≥ 16 | ≥ 400 | 5 % | 5 % | | 100 % | 100 % |
| | | ≥ 20 | ≥ 500 | 5 % | 100 % | | 100 % | 100 % |
| Method | ASME BPVC Sec. V, Article 2 | | | | | | | |
| Extent | Areas defined by ASME B16.34 for special class valves, at abrupt changes in sections and at the junctions of risers, gates or feeders to the casting | | | | 100 % ^d | | | |
| Acceptance criteria | ASME BPVC Sec. VIII, Div. 1, Appendix 7 | | | | | | | |
| <p>NOTE N/R means not required, unless specified otherwise by the purchaser.</p> <p>^a Production valve casting, RT shall be according to the applicable valve specification. If a QSL is not specified by the purchaser, the requirements in this table shall apply.</p> <p>^b Production casting other than valve casting.</p> <p>^c Frequency of inspection 100 % means that each item shall be examined. When random examination (5 %) is specified, a minimum of one item per lot of each pattern in any purchase order shall be examined.</p> <p>^d Production casting other than valve casting, inspection shall include other critical areas as defined in the purchase order and/or applicable product specification or standard. Sketches of the areas to be tested shall be established and agreed with the purchaser.</p> | | | | | | | | |

| | |
|--------------------------|--|
| Repair of Defects | <p>Repairs as described in A351 section 10.2 shall be considered major. All major repairs shall be documented in accordance with A703 S20.2.</p> <p>The repair welding procedure shall be qualified in accordance with ASTM A488 or ISO 11970 and this MDS</p> <ul style="list-style-type: none"> - welding procedure shall be qualified on casting or plate of the same cast material grade as used in production; - testing methodology and acceptance criteria shall be in accordance with the requirements of this MDS for the parent material. <p>Weld repairs are not acceptable for castings that leak during pressure testing.</p> <p>Solution annealing heat treatment is required after all major weld repairs.</p> <p>If a minor cosmetic repair is required to a semi-finished or finished cast component, heat treatment may be omitted provided the welding procedure meets all the test requirements of this data sheet in the as-welded condition.</p> |
|--------------------------|--|

| Material Data Sheet | | | | |
|--|--|-------|------------------|---------------------------------|
| MDS No. IS226 / IS226S ^a | | | Rev. 01 | |
| TYPE OF MATERIAL: Austenitic Stainless Steel, Type 304 | | | | |
| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
| Castings | ASTM A351 | CF8 | | ASTM A351 S5, S6, ASTM A703 S20 |
| | ASTM A351 | CF3 | | ASTM A351 S5, S6, ASTM A703 S20 |
| Page 3 of 3 | | | | |
| Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^a | <p>When sour service requirements are specified by the purchaser, the material shall conform to the requirements of ISO 15156 /NACE MR0175 or ISO 17945 /NACE MR0103, and the following additional requirements to the MDS:</p> <p><u>Hardness testing</u></p> <ul style="list-style-type: none"> - Production hardness testing shall be performed in accordance with the requirements in ASTM A370/A1058 on the pilot casting and one casting per lot thereafter. The maximum hardness shall be 22HRC from three readings taken in close proximity. - Welding procedure qualification testing for all repair welding on shall meet the requirements of NACE MR0175-2 /ISO 15156-3, 6.2.6 with a maximum hardness of 70.8HR 15N or 250HV. <p>The material shall be traceable in accordance with ISO 15156-3 /NACE MR0175-3 section 7.2 and this MDS.</p> | | | |
| Surface Treatment and Finish | Finished castings shall be pickled. Machined surfaces do not require pickling. | | | |
| Marking | The castings shall be marked to ensure full traceability to heat and heat treatment lot. | | | |
| Certification | <p>The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser.</p> <p>The inspection documents shall be in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification.</p> <p>The inspection documents shall include the following information:</p> <ul style="list-style-type: none"> - Heat treatment conditions. | | | |
| <p>^a The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.</p> | | | | |

| Material Data Sheet | | MDS No. IS227 / IS227S ^a | | Rev. 01 |
|---|--|-------------------------------------|------------------|---------------------------|
| TYPE OF MATERIAL: Austenitic Stainless Steel, Type 304 | | | | |
| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
| Bars | ASTM A276 | 304 | | |
| | ASTM A479 | 304 | | |
| Page 1 of 2 | | | | |
| Scope | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| Manufacturing | Bars shall be hot or cold finished cylindrical shaped with maximum diameter of 300 mm (12 in). NOTE Cold finishing shall be restricted to turning, grinding or polishing (singly or in combination); cold drawing or cold forming is not permitted. | | | |
| Chemical Composition | The chemical composition shall comply with UNS S30403 (dual certified 304/304L). | | | |
| Heat Treatment | Bars shall be supplied in the solution annealing conditions. Bars shall be placed in such a way as to ensure free circulation around each bar during the heat treatment process including possible quenching operation. | | | |
| Tensile Testing | Where tensile testing in both directions is required by this MDS, all tensile tests shall meet the specified properties of the referenced standard specification in both directions. | | | |
| Test Sampling | The mid-length of axial (longitudinal) and tangential (transverse) tensile specimens shall be located at a distance equal to the bar outside diameter or minimum of 100 mm (4 in), whichever is the greater, from the end of the bar. The centreline of tensile specimen shall be located at a distance from the bar surface in accordance with ASTM A370 Annex A. <u>Valve parts manufactured from bar</u> For bars with outside diameter ≥ 100 mm (4 in) intended for machining of valve parts, tensile testing shall be taken in both the longitudinal and transverse direction. | | | |
| Non-Destructive Testing | <u>Visual Inspection</u> VT shall be carried out on each bar in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be cleaned prior to the testing. <hr/> <u>NDT valve parts manufactured from bar</u> Inspection of valve parts manufactured from bar shall be according to the applicable valve specification. If a QSL is not specified by the purchaser, the requirements in this MDS shall apply. | | | |
| Repair of Defects | Weld repair is not permitted. | | | |
| Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^a | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of ISO 15156 /NACE MR0175 or ISO 17945 /NACE MR0103, and the following additional requirements to the MDS: <hr/> <u>Hardness testing</u> Production hardness testing shall be performed in accordance with the requirements in ASTM A370/A1058 on the end surface of one bar per lot. The maximum hardness shall be 22HRC from three readings taken in close proximity. <hr/> The material shall be traceable in accordance with ISO 15156-3 /NACE MR0175-3 section 7.2 and this MDS. | | | |
| Surface Treatment and Finish | Finished bars shall be pickled or bright annealed. Machined surfaces do not require pickling. | | | |
| Marking | The bars shall be marked to ensure full traceability to heat and heat treatment lot. | | | |

| Material Data Sheet | | MDS No. IS227 / IS227S ^a | | Rev. 01 |
|---|---|-------------------------------------|-------------------------|----------------------------------|
| TYPE OF MATERIAL: Austenitic Stainless Steel, Type 304 | | | | |
| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
| Bars | ASTM A276 | 304 | | |
| | ASTM A479 | 304 | | |
| Page 2 of 2 | | | | |
| Certification | <p>The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser.</p> <p>The inspection documents shall be in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification.</p> <p>The inspection documents shall include the following information:</p> <ul style="list-style-type: none"> - Heat treatment conditions; - The inspection documents shall confirm compliance to both UNS S30403 and S30400. | | | |
| ^a The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service. | | | | |

Material Data Sheet **MDS No. IS228 / IS228S^a** **Rev. 01**

TYPE OF MATERIAL: Austenitic Stainless Steel, Type 304

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|---------------------|-----------------|--------------|-------------------------|----------------------------------|
| Tubes | ASTM A269 | 304 | | |

Page 1 of 1

| | |
|---|---|
| Scope | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. |
| Chemical Composition | The chemical composition shall comply with UNS S30403 (dual certified 304/304L). |
| Tensile Testing | The following acceptance criteria shall apply: $R_{p0.2} \geq 207$ MPa (30 ksi); $R_m \geq 517$ MPa (75 ksi); $A \geq 35$ % |
| Extent of Testing | Tensile testing shall be carried out for each lot as defined in the standard for mechanical tests. |
| Non-Destructive Testing | Welded tubes: non-destructive electric testing is required. |
| Repair of Defects | Weld repair of base material is not permitted. For repair of welds, the requirements for production welding above shall apply to the repair WPS. Repair welds shall be heat treated as per original production weld. |
| Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^a | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of ISO 15156 /NACE MR0175 or ISO 17945 /NACE MR0103, and the following additional requirements to the MDS: <u>Hardness testing</u> Production hardness testing shall be performed in accordance with the requirements in ASTM A269. The material shall be traceable in accordance with ISO 15156-3 /NACE MR0175-3 section 7.2 and this MDS. |
| Surface Treatment and Finish | Finished tubes shall be pickled or bright annealed. Machined surfaces do not require pickling. |
| Marking | The tubes shall be marked to ensure full traceability to heat and heat treatment lot. |
| Certification | The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser. The inspection documents shall be in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification. The inspection documents shall include the following information: - Heat treatment conditions; - The inspection documents shall confirm compliance to both UNS S30403 and S30400. |

^a The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| Material Data Sheet | | MDS No. IT101 / IT101S ^a | | Rev. 01 |
|--|---|-------------------------------------|------------------|---------------------------|
| TYPE OF MATERIAL: Titanium Grade 2 | | | | |
| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
| Seamless pipes | ASTM B861 | 2 (UNS R50400) | | |
| Page 1 of 1 | | | | |
| Scope | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| Qualification | Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or NORSOK M-650. The qualification testing shall meet the requirements of this MDS. | | | |
| Repair of Defects | Repair welding is not permitted. | | | |
| Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^a | <p>When sour service requirements are specified by the purchaser, the material shall conform to the requirements of ISO 15156 /NACE MR0175 or ISO 17945 /NACE MR0103, and the following additional requirements to the MDS:</p> <p><u>Hardness testing</u></p> <p>Production hardness testing shall be performed in accordance with the requirements in ASTM A370/A1058 on one length of pipe per lot. The maximum hardness shall be 100HRB from three readings taken in close proximity at each location.</p> <p>The material shall be traceable in accordance with ISO 15156-3 /NACE MR0175-3 section 7.2 and this MDS.</p> | | | |
| Certification | <p>The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser.</p> <p>The inspection documents shall be issued in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification.</p> <p>The inspection documents shall include the following information:</p> <ul style="list-style-type: none"> - MPS identification or MCPR/QTR number used. | | | |
| <p>^a The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.</p> | | | | |

Material Data Sheet **MDS No. IT102 / IT102S^a** **Rev. 01**

TYPE OF MATERIAL: Titanium Grade 2

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|---------------------|-----------------|----------------|-------------------------|----------------------------------|
| Welded pipes | ASTM B862 | 2 (UNS R50400) | | ASTM B862 S1.1 |

Page 1 of 1

Scope This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification.

Qualification Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or NORSOK M-650. The qualification testing shall meet the requirements of this MDS.

Welding Welding procedures shall be qualified in accordance with ASME BPVC Sec. IX or ISO 15614-5.

Non-Destructive Testing Method and acceptance criteria for penetrant testing shall be to ASME BPVC Sec. VIII, Div. 1, Appendix 8. B862 supplementary requirement S1.1 shall apply.

Repair of Defects Repair welding of base material is not permitted.
For repair of welds, the requirements for production welding shall apply to the repair WPS. Repair welds shall be heat treated as per original production weld (if applicable).

Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^a When sour service requirements are specified by the purchaser, the material shall conform to the requirements of ISO 15156 /NACE MR0175 or ISO 17945 /NACE MR0103, and the following additional requirements to the MDS:

Hardness testing

- Production hardness testing shall be performed in accordance with the requirements in ASTM A370/A1058 on one length of pipe per lot. The maximum hardness of the base material, HAZ and weld metal shall be 100HRB from three readings taken in close proximity at each location.
- Welding procedure qualification testing for manufacturing and any repair welding shall meet the requirements of NACE MR0175-3 /ISO 15156-3 section 6.2.2, with a maximum hardness of 70.8HR 15N or 250HV.

The material shall be traceable in accordance with ISO 15156-3 /NACE MR0175-3 section 7.2 and this MDS.

Certification The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser.
The inspection documents shall be issued in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification.
The inspection documents shall include the following information:

- MPS identification or MCPR/QTR number used.

^a The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

Material Data Sheet **MDS No. IT103 / IT103S^a** **Rev. 01**

TYPE OF MATERIAL: Titanium Grade 2

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|------------------|-----------|---------------------------|------------------|---------------------------|
| Wrought fittings | ASTM B363 | WPT2 / WPT2W (UNS R50400) | | ASTM B363 S1 |

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Scope
This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification.

Qualification
Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or NORSOK M-650. The qualification testing shall meet the requirements of this MDS.

Heat Treatment
Annealed condition unless the tensile properties in the referenced standard can be achieved in the as formed condition.

Extent of Testing
Tensile test specimens shall be taken from each heat and heat treatment lot, for each type and size.

Non-Destructive Testing

Liquid penetrant testing
ASTM B363 Supplementary requirement S1 shall apply as amended by this MDS:

| NDE Requirement | Nominal Thickness | |
|------------------------|---|------------------------------|
| | Seamless fittings | Welded fittings ^a |
| Frequency ^b | 10 % | 100 % |
| Method | ASME BPVC Sec. V, Article 6 | |
| Extent ^c | 100 % | |
| Acceptance criteria | ASME BPVC Sec. VIII, Div. 1, Appendix 8 | |

NOTE The testing shall be carried out after machining, if applicable. Non-machined surfaces shall be cleaned prior to the testing.

^a Welded fittings of size DN > 50 (NPS > 2).
^b Frequency of inspection 100 % means that each item shall be examined. When random examination (10 %) is specified, a minimum of one item per lot in any purchase order shall be examined. The test lot shall be as defined for mechanical testing.
^c All accessible internal and external surfaces shall be examined.

Repair of Defects
Repair welding of base material is not permitted.
For repair of welds, the requirements for production welding shall apply to the repair WPS. Repair welds shall be heat treated as per original production weld (if applicable)

Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^a

When sour service requirements are specified by the purchaser, the material shall conform to the requirements of ISO 15156 /NACE MR0175 or ISO 17945 /NACE MR0103, and the following additional requirements to the MDS:

Hardness testing

- Seamless fittings:
 - Production testing shall be performed in accordance with the requirements in ASTM A370/A1058 on one fitting per lot. The maximum hardness shall be 100HRB from three readings taken in close proximity.
- Welded fittings:
 - Welding procedure qualification testing for manufacturing and any repair welding shall meet the requirements of NACE MR0175-3 /ISO 15156-3 section 6.2.2 with a maximum hardness of 70.8HR 15N or 250HV.
 - Production testing shall be performed in accordance with the requirements in ASTM A370/A1058 on one fitting per lot. The maximum hardness of the base material, HAZ and weld metal shall be 100HRB from three readings taken in close proximity at each location.

The material shall be traceable in accordance with ISO 15156-3 /NACE MR0175-3 section 7.2 and this MDS.

Material Data Sheet **MDS No. IT103 / IT103S^a** **Rev. 01**

TYPE OF MATERIAL: *Titanium Grade 2*

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|-------------------------|-----------------|---------------------------|-------------------------|----------------------------------|
| Wrought fittings | ASTM B363 | WPT2 / WPT2W (UNS R50400) | | ASTM B363 S1 |

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| | |
|----------------------|---|
| Certification | <p>The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser.</p> <p>The inspection documents shall be issued in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification.</p> <p>The inspection documents shall include the following information:</p> <ul style="list-style-type: none"> - MPS identification or MCPR/QTR number used. |
|----------------------|---|

^a The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

Material Data Sheet**MDS No. IT104 / IT104S^a****Rev. 01**

TYPE OF MATERIAL: *Titanium Grade 2*

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|--------------|-----------|-----------------|------------------|---------------------------|
| Forgings | ASTM B381 | F2 (UNS R50400) | | |

Page 1 of 1

Scope This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification.

Qualification Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or NORSOK M-650. The qualification testing shall meet the requirements of this MDS.

Extent of Testing Tensile test specimens shall be taken from each heat and heat treatment lot, with a maximum deviation from the test block thickness of ±10mm (±0.4 in).

Non-Destructive Testing

Visual Inspection
VT shall be carried out on each forging in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be pickled prior to the testing.

Liquid penetrant testing

| NDE Requirement | Forgings |
|------------------------|---|
| Frequency ^b | 10 % |
| Method | ASME BPVC Sec. V, Article 6 |
| Extent ^c | 100 % |
| Acceptance criteria | ASME BPVC Sec. VIII, Div. 1, Appendix 8 |

NOTE The testing shall be carried out after machining, if applicable. Non-machined surfaces shall be cleaned prior to the testing.

^a Parts of size DN > 50 (NPS > 2).
^b For random examination (10 %), a minimum of one item per lot in any purchase order shall be examined. The test lot shall be as defined for mechanical testing.
^c All accessible internal and external surfaces shall be examined..

Valve forgings NDT
Valve forgings inspection shall be according to the applicable valve specification.
If a QSL is not specified by the purchaser, the requirements in this MDS shall apply.

Repair of Defects Repair welding is not permitted.

Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^a

When sour service requirements are specified by the purchaser, the material shall conform to the requirements of ISO 15156 /NACE MR0175 or ISO 17945 /NACE MR0103, and the following additional requirements to the MDS:

Hardness testing
Production hardness testing shall be performed in accordance with the requirements in ASTM A370/A1058 on one forging per lot. The maximum hardness shall be 100HRB from three readings taken in close proximity at each location.

The material shall be traceable in accordance with ISO 15156-3 /NACE MR0175-3 section 7.2 and this MDS.

Certification

The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser.

The inspection documents shall be issued in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification.

The inspection documents shall include the following information:

- MPS identification or MCPR/QTR number used.

^a The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| Material Data Sheet | | | | | MDS No. IT105 / IT105S ^a | | Rev. 01 | |
|---|---|----------------|------------------|---------------------------|-------------------------------------|--|---------|--|
| TYPE OF MATERIAL: Titanium Grade 2 | | | | | | | | |
| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT | | | | |
| Plates, sheets, strips | ASTM B265 | 2 (UNS R50400) | | | | | | |
| Page 1 of 1 | | | | | | | | |
| Scope | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | | | | | |
| Qualification | Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or NORSOK M-650. The qualification testing shall meet the requirements of this MDS. | | | | | | | |
| Repair of Defects | Repair welding is not permitted. | | | | | | | |
| Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^a | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of ISO 15156 /NACE MR0175 or ISO 17945 /NACE MR0103, and the following additional requirements to the MDS: | | | | | | | |
| | <u>Hardness testing</u> | | | | | | | |
| | Production hardness testing shall be performed in accordance with the requirements in ASTM A370/A1058 on one plate per lot. The maximum hardness shall be 100HRB from three readings taken in close proximity at each location. | | | | | | | |
| | The material shall be traceable in accordance with ISO 15156-3 /NACE MR0175-3 section 7.2 and this MDS. | | | | | | | |
| Certification | <p>The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser.</p> <p>The inspection documents shall be issued in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification.</p> <p>The inspection documents shall include the following information:</p> <ul style="list-style-type: none"> - MPS identification or MCPR/QTR number used. | | | | | | | |
| ^a The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service. | | | | | | | | |

Material Data Sheet **MDS No. IT106 / IT106S^a** **Rev. 01**

TYPE OF MATERIAL: Titanium Grade 2

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|---------------------|-----------------|-----------------|-------------------------|----------------------------------|
| Castings | ASTM B367 | C2 (UNS R52550) | | ASTM B367 S1, S2, S5, S7 |

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Scope This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification.

Qualification Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or NORSOK M-650. The qualification testing shall meet the requirements of this MDS.

Manufacturing All castings shall be subject to hot isostatic pressing (HIP).

Heat Treatment All castings, which due to size limitations cannot be HIP, shall be heat treated and radiographed. When the HIP operation is applied, this shall be in accordance with ASTM A1080.

Test Sampling Samples for production testing shall be cut from the gating system of the casting. For castings with weight 150 kg (331 lb) and above, the test blocks shall be integrally cast with the casting.
 Size of the test block shall be 140 mm (5.5 in) in length and 80 mm (3 in) in height with thickness (T):
 - T = 22 mm (0.86 in) for t ≤ 30 mm (1.18 in)
 - T = 50 mm (2 in) for 30 mm (1.18 in) < t ≤ 60 mm (2.36 in)
 - T = 75 mm (3 in) for t > 60 mm (2.36 in)
 NOTE t = section (shell) thickness of castings; for flanged castings, the largest flange thickness is the ruling thickness.
 Test samples shall accompany the castings through HIP and any heat treatment, chemical cleaning process or any other operation that may alter metallurgical or mechanical properties.

Non-Destructive Testing Visual inspection

| NDE requirement | Pilot casting (section 4.8) | Production casting |
|--|---|---------------------------|
| Frequency | Each pilot casting | Each production casting |
| Method | ANSI/MSS SP-55 | |
| Extent | 100 % of all accessible surfaces including welding ends | |
| Acceptance criteria | MSS SP-55 | |
| NOTE The testing shall be carried out after machining, if applicable. Non-machined surfaces shall be pickled prior to the testing. | | |

Liquid penetrant testing

| NDE Requirement | Pilot casting (section 4.8) | Production casting^a |
|------------------------|---|---|
| Frequency ^b | 100 % | 100 % |
| Method | ASME BPVC Sec. V, Article 6 | ASME BPVC Sec. V, Article 6 |
| Extent ^c | 100 % | 100 % |
| Acceptance criteria | ASME BPVC Sec. VIII, Div. 1, Appendix 7 | ASME BPVC Sec. VIII, Div. 1, Appendix 7 |

NOTE The testing shall be carried out after machining, if applicable. Non-machined surfaces shall be pickled prior to the testing.
^a Production valve castings, PT shall be according to the applicable valve specification. If a QSL is not specified by the purchaser, the requirements in this table shall apply.
^b Frequency of inspection 100 % means that each item shall be examined.
^c All accessible internal and external surfaces shall be examined.

Material Data Sheet**MDS No. IT106 / IT106S^a****Rev. 01**

| | | | | |
|---|-----------------|-----------------|-------------------------|----------------------------------|
| TYPE OF MATERIAL: Titanium Grade 2 | | | | |
| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
| Castings | ASTM B367 | C2 (UNS R52550) | | ASTM B367 S1, S2, S5, S7 |

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| Non-Destructive Testing | <p><u>Radiographic testing</u></p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th rowspan="2">NDE requirement</th> <th rowspan="2">Pilot casting (section 4.8)</th> <th colspan="4">Production casting</th> </tr> <tr> <th colspan="3">Valve castings^a</th> <th>Other pressure containing castings^b</th> </tr> <tr> <td rowspan="4">Frequency^c</td> <td rowspan="4">100 %</td> <th rowspan="2">NPS</th> <th rowspan="2">DN</th> <th colspan="2">Pressure class</th> <td rowspan="4">100 %^d</td> </tr> <tr> <th>≤ 150</th> <th>300</th> </tr> <tr> <td>< 10</td> <td>< 250</td> <td>N/R</td> <td>N/R</td> </tr> <tr> <td>≥ 10</td> <td>≥ 250</td> <td>5 %</td> <td>5 %</td> </tr> <tr> <td>Method</td> <td colspan="5" style="text-align: center;">ASME BPVC Sec. V, Article 2</td> </tr> <tr> <td>Extent</td> <td colspan="3">Areas defined by ASME B16.34 for special class valves, at abrupt changes in sections and at the junctions of risers, gates or feeders to the casting</td> <td colspan="2" style="text-align: center;">100 %^d</td> </tr> <tr> <td>Acceptance criteria</td> <td colspan="5" style="text-align: center;">ASME BPVC Sec. VIII, Div. 1, Appendix 7</td> </tr> <tr> <td colspan="6"> <p>NOTE N/R means not required, unless specified otherwise by the purchaser.</p> <p>^a Production valve casting, RT shall be according to the applicable valve specification. If a QSL is not specified by the purchaser, the requirements in this table shall apply.</p> <p>^b Production casting other than valve casting.</p> <p>^c Frequency of inspection 100 % means that each item shall be examined. When random examination (5 %) is specified, a minimum of one item per lot of each pattern in any purchase order shall be examined.</p> <p>^d Production casting other than valve casting, inspection shall include other critical areas as defined in the purchase order and/or applicable product specification or standard. Sketches of the areas to be tested shall be established and agreed with the purchaser.</p> </td> </tr> </table> | | | | NDE requirement | Pilot casting (section 4.8) | Production casting | | | | Valve castings ^a | | | Other pressure containing castings ^b | Frequency ^c | 100 % | NPS | DN | Pressure class | | 100 % ^d | ≤ 150 | 300 | < 10 | < 250 | N/R | N/R | ≥ 10 | ≥ 250 | 5 % | 5 % | Method | ASME BPVC Sec. V, Article 2 | | | | | Extent | Areas defined by ASME B16.34 for special class valves, at abrupt changes in sections and at the junctions of risers, gates or feeders to the casting | | | 100 % ^d | | Acceptance criteria | ASME BPVC Sec. VIII, Div. 1, Appendix 7 | | | | | <p>NOTE N/R means not required, unless specified otherwise by the purchaser.</p> <p>^a Production valve casting, RT shall be according to the applicable valve specification. If a QSL is not specified by the purchaser, the requirements in this table shall apply.</p> <p>^b Production casting other than valve casting.</p> <p>^c Frequency of inspection 100 % means that each item shall be examined. When random examination (5 %) is specified, a minimum of one item per lot of each pattern in any purchase order shall be examined.</p> <p>^d Production casting other than valve casting, inspection shall include other critical areas as defined in the purchase order and/or applicable product specification or standard. Sketches of the areas to be tested shall be established and agreed with the purchaser.</p> | | | | | |
|---|---|-----------------------------|-------|--------------------|---|-----------------------------|--------------------|--|--|--|-----------------------------|--|--|---|------------------------|-------|-----|----|----------------|--|--------------------|-------|-----|------|-------|-----|-----|------|-------|-----|-----|--------|-----------------------------|--|--|--|--|--------|--|--|--|--------------------|--|---------------------|---|--|--|--|--|---|--|--|--|--|--|
| NDE requirement | Pilot casting (section 4.8) | Production casting | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | Valve castings ^a | | | Other pressure containing castings ^b | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Frequency ^c | 100 % | NPS | DN | Pressure class | | 100 % ^d | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | ≤ 150 | 300 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | < 10 | < 250 | N/R | N/R | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | ≥ 10 | ≥ 250 | 5 % | 5 % | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Method | ASME BPVC Sec. V, Article 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Extent | Areas defined by ASME B16.34 for special class valves, at abrupt changes in sections and at the junctions of risers, gates or feeders to the casting | | | 100 % ^d | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Acceptance criteria | ASME BPVC Sec. VIII, Div. 1, Appendix 7 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| <p>NOTE N/R means not required, unless specified otherwise by the purchaser.</p> <p>^a Production valve casting, RT shall be according to the applicable valve specification. If a QSL is not specified by the purchaser, the requirements in this table shall apply.</p> <p>^b Production casting other than valve casting.</p> <p>^c Frequency of inspection 100 % means that each item shall be examined. When random examination (5 %) is specified, a minimum of one item per lot of each pattern in any purchase order shall be examined.</p> <p>^d Production casting other than valve casting, inspection shall include other critical areas as defined in the purchase order and/or applicable product specification or standard. Sketches of the areas to be tested shall be established and agreed with the purchaser.</p> | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Repair of Defects | <p>All major repairs shall be documented, where a major repair is defined as excavations exceeding 20 % of the casting section or wall thickness, and/or 4 % of the casting surface area.</p> <p>Weld repairs are not acceptable for castings that leak during pressure testing.</p> <p>The repair welding procedure shall be qualified in accordance with ASME IX or ISO 15614-5 and this MDS.</p> | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^a | <p>Material covered by this MDS is not referenced in ISO 15156 /NACE MR0175 or ISO 17945 /NACE MR0103. Use of this material in sour service shall require separate qualification according to ISO 15156-3 /NACE MR0175-3 or ISO 17945 /NACE MR0103, as applicable.</p> <hr/> <p>The material shall be traceable in accordance with ISO 15156-3 /NACE MR0175-3 section 7.2 and this MDS. The inspection documents required in this MDS shall also include the qualification test reports.</p> | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Surface Treatment and Finish | <p>For castings manufactured to this MDS alpha-case in the casting surface shall be completely removed at the foundry from the following locations:</p> <ul style="list-style-type: none"> - All surfaces, which shall be machined. - All weld bevels including an area of 20 mm (0.8 in) on each side of the bevel. - All highly stressed areas including areas prone to fatigue. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

| Material Data Sheet | | MDS No. IT106 / IT106S ^a | | Rev. 01 |
|--|---|-------------------------------------|-------------------------|----------------------------------|
| TYPE OF MATERIAL: Titanium Grade 2 | | | | |
| <i>PRODUCT FORM</i> | <i>STANDARD</i> | <i>GRADE</i> | <i>ACCEPTANCE CLASS</i> | <i>SUPPLEMENTARY REQUIREMENT</i> |
| Castings | ASTM B367 | C2 (UNS R52550) | | ASTM B367 S1, S2, S5, S7 |
| Page 3 of 3 | | | | |
| Certification | <p>The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser.</p> <p>The inspection documents shall be issued in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification.</p> <p>The inspection documents shall include the following information:</p> <ul style="list-style-type: none"> - MPS identification or MCPR/QTR number used. | | | |
| <p>^a The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.</p> | | | | |

| Material Data Sheet | | | | |
|---|---|----------------|-------------------------|----------------------------------|
| MDS No. IT107 / IT107S ^a | | | Rev. 01 | |
| TYPE OF MATERIAL: Titanium Grade 2 | | | | |
| <i>PRODUCT FORM</i> | <i>STANDARD</i> | <i>GRADE</i> | <i>ACCEPTANCE CLASS</i> | <i>SUPPLEMENTARY REQUIREMENT</i> |
| Bars | ASTM B348 | 2 (UNS R50400) | | |
| Page 1 of 1 | | | | |
| Scope | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| Qualification | Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or Norsok M-650. The qualification testing shall meet the requirements of this MDS. | | | |
| Extent of Testing | Tensile test specimens shall be taken from each heat and heat treatment lot. | | | |
| Non-Destructive Testing | <u>Visual Inspection</u> VT shall be carried out on each bar in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be cleaned prior to the testing. | | | |
| | <u>NDT valve parts manufactured from bar</u> Inspection of valve parts manufactured from bar shall be according to the applicable valve specification. If a QSL is not specified by the purchaser, the requirements in this MDS shall apply. | | | |
| Repair of Defects | Repair welding is not permitted. | | | |
| Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^a | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of ISO 15156 /NACE MR0175 or ISO 17945 /NACE MR0103, and the following additional requirements to the MDS: | | | |
| | <u>Hardness testing</u> Production hardness testing shall be performed in accordance with the requirements in ASTM A370/A1058 on the end surface of one bar per lot. The maximum hardness shall be 100HRB from three readings taken in close proximity. | | | |
| | The material shall be traceable in accordance with ISO 15156-3 /NACE MR0175-3 section 7.2 and this MDS. | | | |
| Certification | <p>The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser.</p> <p>The inspection documents shall be issued in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification.</p> <p>The inspection documents shall include the following information:</p> <ul style="list-style-type: none"> - MPS identification or MCPR/QTR number used. | | | |
| ^a The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service. | | | | |

| Material Data Sheet | | MDS No. IT108 / IT108S ^a | | Rev. 01 |
|---|---|-------------------------------------|------------------|---------------------------|
| TYPE OF MATERIAL: Titanium Grade 2 | | | | |
| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
| Tubes | ASTM B338 | 2 (UNS R50400) | | |
| Page 1 of 1 | | | | |
| Scope | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| Qualification | Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or NORSOK M-650. The qualification testing shall meet the requirements of this MDS. | | | |
| Non-Destructive Testing | Method and acceptance criteria for penetrant testing shall be to ASME VIII, Div. 1, Appendix 8. | | | |
| Repair of Defects | Repair welding of base material is not permitted. For repair of welds, the requirements for production welding shall apply to the repair WPS. Repair welds shall be heat treated as per original production weld (if applicable) | | | |
| Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^a | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of ISO 15156 /NACE MR0175 or ISO 17945 /NACE MR0103, and the following additional requirements to the MDS: | | | |
| | <u>Hardness testing</u> | | | |
| | Production hardness testing shall be performed in accordance with the requirements in ASTM A370/A1058 on one tube per lot. The maximum hardness shall be 100HRB from three readings taken in close proximity. The material shall be traceable in accordance with ISO 15156-3 /NACE MR0175-3 section 7.2 and this MDS. | | | |
| Certification | The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser. The inspection documents shall be issued in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification. The inspection documents shall include the following information: – MPS identification or MCPR/QTR number used. | | | |
| ^a The supplementary suffix “S” shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service. | | | | |

Material Data Sheet **MDS No. IU100 / IU100S^a** **Rev. 01**

TYPE OF MATERIAL: Precipitation-Hardened Stainless Steel

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|---------------------|-----------------|------------------------|-------------------------|----------------------------------|
| Bolting | ASTM A453 | Grade 660 (UNS S66286) | Class D | - |

Page 1 of 1

| | |
|---|--|
| Scope | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. |
| Manufacturing | Threading of studs, bolts and screws may be done by machining or rolling. Thread rolling shall be done after heat treatment. Threads in nuts shall be machined. |
| Heat Treatment | Heat treatment shall be carried out after the final hot forming operation. |
| Impact Testing/ Toughness testing | Impact testing shall be carried out at minus 101 °C (-150 °F). The minimum absorbed energy shall be 27 J (20 ft lbf) average and 20 J (15 ft lbf) single, the lateral expansion shall be 0.38 mm (0.015 in). |
| Proof Load Testing | Proof load testing shall be according to ASTM A962 and the load shall comply with ASTM A194 Grade 7. |
| Non-Destructive Testing | All products shall be 100 % visually examined in all areas of threads, shanks and heads. Discontinuities shall comply with requirements specified in ASTM F788 for bolts/studs and ASTM F812 for nuts. |
| Repair of Defects | Weld repair is not permitted. |
| Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^a | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of ISO 15156 /NACE MR0175 or ISO 17945 /NACE MR0103, and the following additional requirements to the MDS: |
| | <u>Hardness testing</u> Production hardness testing shall be performed in accordance with the requirements in ASTM A453. The maximum hardness shall be 35HRC from three readings taken in close proximity. |
| | The material shall be traceable in accordance with ISO 15156-3 /NACE MR0175-3 section 7.2 and this MDS. |
| Marking | Each bolt and nut shall be marked on the end/head to ensure full traceability to heat and heat treatment lot. |
| Certification | The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser. The inspection documents shall be issued in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification. The inspection documents shall include the following information: – Heat treatment condition (solution annealing and annealing temperature) shall be stated. |

^a The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

Material Data Sheet**MDS No. IX100 / IX100S^a****Rev. 01**

TYPE OF MATERIAL: Low alloyed steel fasteners (HDG)

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|--------------|-----------|--------------|------------------|---------------------------|
| Bolting | ASTM A320 | L7, L7M, L43 | | - |
| | ASTM A194 | 7 or 7M | | ASTM A194 S3, S4, S5 |

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|---|--|
| Scope | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. |
| Manufacturing | Threading of studs and bolts may be done by machining or rolling. Thread rolling shall be done after heat treatment. Threads in nuts shall be machined. |
| Impact Testing/ Toughness testing | Nuts to A194: S3 shall apply. |
| Proof Load Testing | Nuts to A194: S4 shall apply. |
| Non-Destructive Testing | All products shall be 100 % visually examined in all areas of threads, shanks and heads. Discontinuities shall comply with requirements specified in ASTM F788 for bolts/studs and ASTM F812 for nuts. |
| Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^a | When sour service is specified by the purchaser, only Grade L7M/7M is acceptable. The material shall be traceable in accordance with ISO 15156-2/NACE MR0175-2 section 9 and this MDS. |
| Surface Treatment and Finish | All studs, bolts, nuts and washers shall be hot dip spun galvanized according to ASTM F2329 or ISO 10684. The zinc coating on threads shall not be subject to cutting, rolling or finishing tool operation. Nuts may be tapped after galvanizing. |
| Dimensional Tolerances | Studs and bolts: - Threading shall be in accordance with ASME B1.1, class 2A fit for diameters 1 in and smaller (UNC series) and 8 pitch thread series for 1 1/8 in and larger. Nuts: - Nuts shall be ASME heavy HEX-series, double chamfered. - Nut threads shall be oversized to fit studs/bolts dependent of specified coating. |
| Certification | The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser. S5 shall apply for nuts to ASTM A194. The inspection documents shall be issued in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification. The inspection documents shall include the following information: - Steel manufacturer of starting material; - Heat treatment condition. |

^a The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

Material Data Sheet**MDS No. IX109 / IX109S^a****Rev. 01**

| TYPE OF MATERIAL: Low alloyed steel fasteners (black/uncoated) | | | | |
|---|---|--------------|------------------|---------------------------|
| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
| Bolting | ASTM A320 | L7, L7M, L43 | | - |
| | ASTM A194 | 7 or 7M | | ASTM A194 S3, S4, S5 |
| Page 1 of 1 | | | | |
| Scope | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| Manufacturing | Threading of studs and bolts may be done by machining or rolling. Thread rolling shall be done after heat treatment. Threads in nuts shall be machined. | | | |
| Impact Testing/ Toughness testing | Nuts to A194: S3 shall apply. | | | |
| Proof Load Testing | Nuts to A194: S4 shall apply . | | | |
| Non-Destructive Testing | All products shall be 100 % visually examined in all areas of threads, shanks and heads. Discontinuities shall comply with requirements specified in ASTM F788 for bolts/studs and ASTM F812 for nuts. | | | |
| Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^a | When sour service is specified by the purchaser, only Grade L7M/7M is acceptable. The material shall be traceable in accordance with ISO 15156-2 /NACE MR0175-2 section 9 and this MDS. | | | |
| Dimensional Tolerances | Studs and bolts: - Threading shall be in accordance with ASME B1.1, class 2A fit for diameters 1 in and smaller (UNC series) and 8 pitch thread series for 1 1/8 in and larger. Nuts: - Nuts shall be ASME heavy HEX-series, double chamfered; - Nut threads shall be oversized to fit studs/bolts dependent of specified coating. | | | |
| Certification | The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser. S5 shall apply for nuts to ASTM A194 The inspection documents shall be issued in accordance with ISO 10474/ EN 10204 Type 3.1 and shall confirm compliance with this specification. The inspection documents shall include the following information: - Steel manufacturer of starting material; - Heat treatment condition. | | | |

^a The supplementary suffix “S” shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

Material Data Sheet **MDS No. IX110 / IX110S^a** **Rev. 01**

TYPE OF MATERIAL: Low alloyed steel fasteners (black/uncoated)

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|---------------------|-----------------|--------------|-------------------------|----------------------------------|
| Bolting | ASTM A193 | B7, B7M | | - |
| | ASTM A194 | 2H, 2HM | | - |

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|---|---|
| Scope | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. |
| Manufacturing | Threading of studs and bolts may be done by machining or rolling. Thread rolling shall be done after heat treatment. Threads in nuts shall be machined. |
| Non-Destructive Testing | All products shall be 100 % visually examined in all areas of threads, shanks and heads. Discontinuities shall comply with requirements specified in ASTM F788 for bolts/studs and ASTM F812 for nuts. |
| Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^a | When sour service is specified by the purchaser, only Grade B7M/2HM is acceptable. The material shall be traceable in accordance with ISO 15156-2 /NACE MR0175-2 section 9 and this MDS. |
| Dimensional Tolerances | Studs and bolts: – Threading shall be in accordance with ASME B1.1, class 2A fit for diameters 1 in and smaller (UNC series) and 8 pitch thread series for 1 1/8 in and larger. Nuts: – Nuts shall be ASME heavy HEX-series, double chamfered. |
| Certification | The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser. The inspection documents shall be issued in accordance with ISO 10474 /EN 10204 Type 2.2 as minimum. |

^a The supplementary suffix “S” shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

Material Data Sheet **MDS No. IX120 / IX120S^a** **Rev. 01**

TYPE OF MATERIAL: Low alloyed steel fasteners (HDG)

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|---------------------|-----------------|--------------|-------------------------|----------------------------------|
| Bolting | ASTM A193 | B7, B7M | | - |
| | ASTM A194 | 2H, 2HM | | - |

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|---|--|
| Scope | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. |
| Manufacturing | Threading of studs and bolts may be done by machining or rolling. Thread rolling shall be done after heat treatment. Threads in nuts shall be machined. |
| Non-Destructive Testing | All products shall be 100 % visually examined in all areas of threads, shanks and heads. Discontinuities shall comply with requirements specified in ASTM F788 for bolts/studs and ASTM F812 for nuts. |
| Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^a | When sour service is specified by the purchaser, only Grade B7M/2HM is acceptable. The material shall be traceable in accordance with ISO 15156-2 /NACE MR0175-2 section 9 and this MDS. |
| Surface Treatment and Finish | All studs, bolts, nuts and washers shall be hot dip spun galvanized according to ASTM F2329 or ISO 10684. The zinc coating on threads shall not be subject to cutting, rolling or finishing tool operation. Nuts may be tapped after galvanizing. |
| Dimensional Tolerances | Studs and bolts: - Threading shall be in accordance with ASME B1.1, class 2A fit for diameters 1 in and smaller (UNC series) and 8 pitch thread series for 1 1/8 in and larger. Nuts: - Nuts shall be ASME heavy HEX-series, double chamfered; - Nut threads shall be oversized to fit studs/bolts dependent of specified coating. |
| Certification | The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser. S5 shall apply for nuts to ASTM A194. The inspection documents shall be issued in accordance with ISO 10474 /EN 10204 type 2.2 as minimum. |

^a The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

Material Data Sheet **MDS No. IX124 / IX124S^a** **Rev. 01**

TYPE OF MATERIAL: *High strength low alloy steel*

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|---------------------|-----------------|--------------|-------------------------|----------------------------------|
| Forgings | ASTM A694 | F52 | - | - |
| | ASTM A694 | F60 | - | - |
| | ASTM A694 | F65 | - | - |

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| Scope | <p>This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification.</p> <p>This MDS applies to pressure controlling parts of valves only.</p> |
| Chemical Composition | C ≤ 0.20 %, S ≤ 0.020 %, P ≤ 0.025 %, Ti ≤ 0.05 %, Nb ≤ 0.04 %, (V + Nb + Ti) ≤ 0.10 %, CE ≤ 0.43 % |
| Heat Treatment | <p>For products delivered in the quenched and tempered condition the minimum tempering temperature shall be 620 °C (1 148 °F).</p> <p>Forgings shall be placed in such a way that free circulation around each forging is ensured during the heat treatment process, including quenching.</p> |
| Impact Testing/ Toughness testing | <p>Impact testing shall be carried out at -46 °C (-50 °F). One set of three samples shall be tested. Test samples shall be taken from the same location and have the same orientation as tensile test specimens. Mid-length of the test piece shall be a distance T or minimum 100 mm (4 in) from any second surface, whichever is greatest where T is the ruling thickness.</p> <p>The minimum absorbed energy for full size specimens shall be 27 J (20 ft lbf) average and 20 J (15 ft lbf) single.</p> |
| Extent of Testing | Impact test, tensile test, hardness test and micrographic examination shall be carried out for each heat, nominal thickness and heat treatment load. For heat treatment in continuous furnace a heat treatment load is defined as all plates heat treated continuously in the same furnace, of the same heat and nominal thickness. A test lot shall not exceed 2 000 kg (4 400 lb) for forgings with as forged weight ≤ 50 kg (110 lb), and 5 000 kg (11 000 lb) for forgings with as forged weight > 50 kg (110 lb). |
| Non-Destructive Testing | <p><u>Visual Inspection</u></p> <p>VT shall be carried out on each forging or bar in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be cleaned prior to the testing.</p> <p>Inspection of pressure controlling parts of valves shall be according to the applicable valve specification. If a QSL is not specified by the purchaser, the requirements in this MDS shall apply.</p> |
| Repair of Defects | Weld repair is not permitted. |
| Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^a | <p>When sour service requirements are specified by the purchaser, the material shall conform to the requirements of ISO 15156 /NACE MR0175 or ISO 17945 /NACE MR0103, and the following additional requirements to the MDS:</p> <p><u>Chemical composition</u></p> <p>Ni < 1.0 %</p> <p><u>Hardness testing</u></p> <p>Production hardness testing shall be performed in accordance with the requirements in ASTM A370/A1058 on two forgings per lot. When only one part is produced, it shall be hardness tested as required. The maximum hardness shall be 22HRC from three readings taken in close proximity.</p> <p>The material shall be traceable in accordance with ISO 15156-2 /NACE MR0175-2 section 9 and this MDS.</p> |
| Marking | The forgings shall be marked to ensure full traceability to melt and heat treatment lot. |

| Material Data Sheet | | MDS No. IX124 / IX124S ^a | | Rev. 01 |
|---|--|-------------------------------------|-------------------------|----------------------------------|
| TYPE OF MATERIAL: High strength low alloy steel | | | | |
| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
| Forgings | ASTM A694 | F52 | - | - |
| | ASTM A694 | F60 | - | - |
| | ASTM A694 | F65 | - | - |
| Page 2 of 2 | | | | |
| Certification | <p>The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser.</p> <p>The inspection documents shall be in accordance with EN 10204 /ISO 10474 Type 3.1, unless specified otherwise by the purchaser.</p> <p>The inspection documents shall include the following information:</p> <ul style="list-style-type: none"> - Steel manufacturer, melting and refining practice; - Heat treatment condition. For tempered condition, tempering temperature and holding time shall be stated. | | | |
| ^a The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service. | | | | |

Material Data Sheet **MDS No. IX127 / IX127S^a** **Rev. 01**

TYPE OF MATERIAL: High strength low alloy steel

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|---------------------|-----------------|--------------|-------------------------|----------------------------------|
| Bars | ASTM A29 | 4140 | - | - |
| | ASTM A694 | F52 | - | - |
| | ASTM A694 | F60 | - | - |
| | ASTM A694 | F65 | - | - |

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| Scope | <p>This MDS defines applicable options and/or requirements that supplement or amend the referenced ASTM standard specification.</p> <p>Valve parts machined from bar covered by this MDS are restricted to pressure controlling parts only.</p> |
| Manufacturing | <p>Bars shall be manufactured to the following requirements:</p> <ul style="list-style-type: none"> - bar forgings as defined in ASTM A788 and certified to ASTM A694; or - hot rolled/wrought bars with a maximum outside diameter 250 mm (10 in); or - All bars shall be supplied in heat treatment condition as specified below. <p>NOTE Cold finishing shall be restricted to turning, grinding or polishing (singly or in combination); cold drawing or cold forming is not permitted.</p> |
| Chemical Composition | <p>Grade 4140: S ≤ 0.020 %, P ≤ 0.025 %</p> <p>Grade F52, F60, F65:</p> <p>C ≤ 0.20 %, S ≤ 0.020 %, P ≤ 0.025 %, Ti ≤ 0.05 %, Nb ≤ 0.04 %, (V + Nb + Ti) ≤ 0.10 %, CE ≤ 0.43</p> |
| Heat Treatment | <p>Grade 4140: for products delivered in quenched and tempered condition the minimum tempering temperature shall be 650 °C (1 202 °F).</p> <p>Grade F52, F60, F65: for products delivered in the quenched and tempered condition the minimum tempering temperature shall be 620 °C (1 148 °F).</p> <p>Bars shall be placed in such a way that free circulation around each bar is ensured during the heat treatment process, including quenching.</p> |
| Tensile Testing | <p>Grade 4140:</p> <ul style="list-style-type: none"> - Minimum yield strength: ≥ 515 MPa (75 ksi) - Minimum tensile strength: ≥ 690 MPa (100 ksi) - Minimum elongation: ≥ 15 % |
| Impact Testing/ Toughness testing | <p>Impact testing shall be carried out at -46 °C (-50 °F). One set of three samples shall be tested.</p> <p>Acceptance criteria:</p> <ul style="list-style-type: none"> - Grade 4140, minimum 45 J (33 ft lbf) average and 35 J (26 ft lbf) single for full size specimens; - Grade F52, F60, F65, minimum 27 J (22 ft lbf) average and 20 J (15 ft lbf) single for full size specimens. |
| Extent of Testing | <p>Impact test, tensile test and hardness test shall be carried out for each heat, nominal thickness and heat treatment load. For heat treatment in continuous furnace a heat treatment load is defined as all bars heat treated continuously in the same furnace, of the same heat and nominal thickness. A test lot shall not exceed 2 000 kg (4 400 lb) for bars with weight ≤ 50 kg (110 lb), and 5 000 kg (11 000 lb) for forgings with weight > 50 kg (110 lb).</p> |
| Test Sampling | <p><u>Valve parts manufactured from bar</u></p> <p>Sampling of test specimens for bars intended for machining pressure controlling parts of valve DN 100 (NPS 4) and under shall comply with the following requirements:</p> <ul style="list-style-type: none"> - The mid-length of the axial tensile test specimen shall be located at a distance equal to the bar outside diameter or minimum of 100 mm (4 in), whichever is the greater, from the end of the bar, and the centreline of the specimen shall be located at a minimum distance of OD/4 from the surface. - The centreline of the tangential tensile test specimen shall be located at a minimum distance of OD/4 from the surface and the mid-point of the specimens at a minimum of 100 mm (4 in) from the end of the bar. - The notch of the impact test specimen shall be located perpendicular to the bar surface. |

Material Data Sheet **MDS No. IX127 / IX127S^a** **Rev. 01**

TYPE OF MATERIAL: High strength low alloy steel

| PRODUCT FORM | STANDARD | GRADE | ACCEPTANCE CLASS | SUPPLEMENTARY REQUIREMENT |
|--------------|-----------|-------|------------------|---------------------------|
| Bars | ASTM A29 | 4140 | - | - |
| | ASTM A694 | F52 | - | - |
| | ASTM A694 | F60 | - | - |
| | ASTM A694 | F65 | - | - |

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Test Sampling

- For bar with outside diameter < 100 mm (4 in): one tensile and one set impact test specimens shall be taken.
- For bar with outside diameter ≥ 100 mm (4 in): one tensile and one set impact test specimens shall be taken in axial direction of the bar. In addition, one tensile test specimen and one set impact test specimens shall be taken in tangential direction of the bar; the centreline of the tensile test specimen shall be located a minimum of 100 mm (4 in) from the end of the bar.
- The specified minimum tensile strength of the referenced standard specification and impact energies specified in this data sheet shall be met in both directions.

Non-Destructive Testing

Visual Inspection
 VT shall be carried out on each bar in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be cleaned prior to the testing.

NDT of valve parts manufactured from bar
 Inspection of valve parts manufactured from bar shall be according to the applicable valve specification. If a QSL is not specified by the purchaser, the requirements in this MDS shall apply.

Repair of Defects
 Weld repair is not permitted.

Sour Service (additional metallurgical, manufacturing, testing and certification requirements)^a

Grade 4140 bar
 Grade 4140 material is not referenced in ISO 15156 /NACE MR0175 nor ISO 17945 /NACE MR0103.
 NOTE Use of Grade 4140 in sour service shall require separate qualification according to ISO 15156-2/NACE MR0175-2 or ISO 17945/NACE MR0103, as applicable.
 The inspection documents required in this MDS shall also include the qualification test reports.

Grade F52, F60, F65 bar
 When sour service requirements are specified by the purchaser, Grade F52, F60, F65 bar material shall conform to the requirements of ISO 15156/NACE MR0175 or ISO 17945/NACE MR0103, and the following additional requirements to the MDS:

Chemical composition
 Ni < 1.0 %

Hardness testing
 Production hardness testing shall be performed in accordance with the requirements in ASTM A370/A1058 on the end surface of one bar per lot. The maximum hardness shall be 22HRC from three readings taken in close proximity.

The material shall be traceable in accordance with ISO 15156-2 /NACE MR0175-2 section 9 and this MDS.

Marking
 The bars shall be marked to ensure full traceability to melt and heat treatment lot.

Certification

The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by the purchaser.

The inspection documents shall be in accordance with EN 10204 /ISO 10474 Type 3.1, unless specified otherwise by the purchaser.

The inspection documents shall include the following information:

- Steel manufacturer, melting and refining practice;
- Heat treatment condition. For tempered condition, tempering temperature and holding time shall be stated.

^a The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

Annex B (normative) Element Data Sheets

B.1 List of element data sheets

The element data sheets listed in Table 3 cover requirements for special processes, where the process shall be qualified and controlled as specified in the applicable EDS to ensure products are manufactured consistently to the appropriate quality.

Table 3 – List of element data sheets

| Special process description | EDS No. | EDS Rev. |
|---|----------------|-----------------|
| Hard facing by overlay welding | IH001 | 01 |
| Hard facing by thermal spraying of tungsten carbide | IH002 | 01 |
| Electroless nickel coating | IH004 | 01 |
| Solid tungsten carbide material | IH005 | 01 |
| Alloy 625 corrosion resistant overlay welding | IO001 | 01 |

B.2 IOGP element data sheets

| Element Data Sheet | | EDS No. IH001 | Rev. 01 |
|--|--|---------------|---------|
| Type of Special process: Hard facing by overlay welding | | | |
| Page 1 of 2 | | | |
| Scope | This EDS specifies requirements for hard facing by overlay welding of piping and valve parts. | | |
| Welding | <p><u>Welding process</u></p> <p>The hard facing shall be made by a suitable weld overlay process such as PTAW (plasma transferred arc welding), GTAW (gas tungsten inert gas welding) or LBW/EBW (laser/electron beam welding).</p> <p><u>Welding Consumable</u></p> <p>For general and hydrocarbon service the welding consumables shall be of type E/ERCoCr-A (UNS R30006) e.g. Stellite 6 or equivalent, or type 13Cr (ER410).</p> <p>For other services, except for seawater service the use of E/ERCoCr-B (UNS R30012) or E/ERCoCr-E (UNS R30021) should be considered subject to purchaser approval.</p> <p>For seawater service, the consumable shall be subject to agreement with the purchaser.</p> | | |
| Procedure Qualification Testing | <p><u>General</u></p> <p>The hard facing shall be carried out using welding procedures qualified in accordance with ASME IX or ISO 15614-7 modified as follows:</p> <ul style="list-style-type: none"> - The test plate dimensions shall be the minimum required by the welding standard sufficient to allow all required tests to be carried out. The minimum qualified parent material thickness shall be the thickness of the test plate. - The qualification shall be carried out on base material of same specification and grade as used in production. - The testing shall be carried out according to ASME IX or ISO 15614-7 and the requirements in this EDS. <p>A stringer bead technique is recommended. If weaving is used, the width shall be within the qualified range taking into consideration the risk of overheating of the material and cracking.</p> <p>The temperature of the components shall be checked during welding. The interpass temperature during hard facing of duplex stainless steels shall not exceed 150 °C (302 °F).</p> <p>The thickness of the hard facing shall be measured and be minimum 1.6 mm (0.06 in) after final machining.</p> <p><u>Hardness testing</u></p> <p>Hardness testing shall be carried out on base material, heat affected zone and weld metal. Vickers hardness HV5 or HV10 shall be used. The examination of the HAZ shall be carried out with maximum 0.5 mm (0.02 in) distance between the indentations from fusion line, through HAZ into the unaffected base material. The hardness for HAZ and unaffected base material shall not exceed the maximum values specified in ISO 15156 /MR0175 or ISO 17945 /NACE MR0103 and for type 22Cr and 25Cr duplex base materials the hardness shall not exceed 310HV average, 320HV individual single value.</p> <p><u>Metallographic examination</u></p> <p>Metallographic examination shall be carried out for the following materials: 22Cr and 25Cr duplex, type 6Mo austenitic stainless steels and Alloy 625. For type 22Cr and 25Cr duplex the ferrite content in the heat affected zone shall be determined in accordance with ASTM E562 and shall be in the range of 30 % to 70 %.</p> <p><u>Corrosion testing</u></p> <p>Corrosion testing shall be carried out for 25Cr duplex, Super austenitic materials (UNS S34565 or equivalent), Alloy 625 and 6Mo substrates. The testing shall be carried out according to ASTM G48, method A, and for 24 h exposure time at 40 °C (104 °F). The acceptance criteria shall be no pitting at 20x magnification and maximum weight loss shall be 4 g/m². The sample shall include the cross section from the overlay surface into the unaffected base material. The hard facing may be removed, but any buffer layer and heat affected zone in the base material shall be exposed in the corrosion test.</p> <p><u>Macro section</u></p> <p>The macro section for the qualification shall show no cracking and complete fusion between base material and the hard facing layer.</p> | | |

| Element Data Sheet | | EDS No. IH001 | Rev. 01 |
|--|---|---------------|---------|
| Type of Special process: Hard facing by overlay welding | | | |
| Page 2 of 2 | | | |
| Procedure Qualification Testing | <p><u>Impact testing</u></p> <p>The qualification testing shall include Charpy V-notch impact testing for materials that require impact testing by the applicable ASTM standard or MDS. The test conditions and acceptance criteria shall be as stated in the ASTM standard or MDS (the MDS requirements prevail). One set of impact testing shall be carried out with specimens located in the base material 2 mm (0.08 in) below the fusion line between the hard facing and base material. The notch shall be perpendicular to the hard faced surface.</p> | | |
| Heat Treatment | <p>Heat treatment after hard facing shall be carried out, as necessary, to meet specified properties. Components to be exposed to H₂S containing environment shall be heat treated as required in ISO 15156 /NACE MR0175 or ISO 17945 /NACE MR0103, as applicable.</p> <p>Overlaying low alloy steels and martensitic stainless steels (13% Cr, 13% Cr 4% Ni) shall be followed by stress relieving at a minimum temperature of 620 °C (1 148 °F).</p> | | |
| Non-Destructive Testing | <p><u>Visual Inspection</u></p> <p>VT shall be carried out on each 100 % of the weld overlay according to ASME BPVC Sec. V, Article 9 or ISO 17637. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be cleaned prior to the testing. Porosity, slag inclusions are not permitted on and within 50 mm (2 in) of sealing surfaces.</p> <p><u>Liquid penetrant testing</u></p> <p>All deposited surfaces shall, after final machining, be penetrant tested in accordance with ASME V Article 6 with acceptance criteria according to ASME VIII, Div. 1, Appendix 8, except on sealing surfaces where no indication is acceptable (actual sealing surface areas to be defined by purchaser).</p> | | |
| Repair of Defects | <p>Repairs may be local or total when non-conforming conditions are found. Defects in excess of acceptance standard shall be removed by reducing weld overlay thickness and shall be repaired by re-welding.</p> <p>All excavations shall be dye penetrant inspected prior to the start of repair welding in order to confirm the complete removal of defects.</p> <p>Repair by re-welding shall be performed in accordance with a written procedure. The following information must be given in these procedures:</p> <ul style="list-style-type: none"> - Method of removing defects; - Requirements related to the shape of the excavation; - Inspection of repair prior to re-welding; - Applicable welding procedure and qualification tests; - Inspection after welding. | | |

Element Data SheetEDS No. IH002Rev. 01

Type of Special process: Hard facing by thermal spraying of tungsten carbide

Page 1 of 2

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|--|--|
| Scope | This EDS specifies requirements for hard facing by thermal spraying of tungsten carbide of piping and valve parts. |
| Process | <p><u>General</u> The hard facing shall be carried out using high velocity oxygen fuel (HVOF) or equivalent process.</p> <p><u>Coating composition</u> The coating shall be of cermet type based on tungsten carbide (WC) and a metallic binder. The binder shall be based on Co and/or Ni which shall be alloyed with Cr or Cr and Mo. Pure Co or Ni binders are not accepted.</p> <p><u>Coating thickness</u> The coating thickness shall be in the range 0.15 mm to 0.25 mm (0.006 in to 0.01 in) after grinding and lapping, unless specified otherwise by the purchaser.</p> <p><u>Surface preparation</u> The components shall be cleaned for removal of oil by a cleaning agent (acetone or similar) before grit blasting with aluminium oxide. The surface roughness before spraying shall be within the range 4 µm to 8 µm (160 µin to 320 µin) Ra. All edges shall be chamfered or rounded. Balls shall be spherical within 0.05 mm (0.002 in). The components shall be at a temperature minimum 10 °C (50 °F) above dew point and be immediately grit blasted in warm condition. Any oil, dust or particles shall be removed by suitable means before spraying.</p> <p><u>Thermal spraying</u> The component shall be coated immediately after grit blasting, while the component still is at a temperature above the dew point. All thermal spraying shall be carried out under optimal conditions and accordance with established and qualified procedures to ensure that the coating on all areas fulfil the specified requirements. For valves all seating area shall be coated. For ball valves the complete spherical part of the ball shall be coated. For gate valves all surfaces sliding against the seats during valve opening and closing shall be coated.</p> <p><u>Sealing</u> All coated surfaces shall be sealed when carbon or low alloy steel is the base material. If sealer is used, the type of sealer and testing requirements shall be agreed with the purchaser and be specified in the procedure.</p> <p><u>Finishing</u> All coated parts shall be ground and lapped to a mirror like finish and maximum roughness of Ra = 0.15 µm (6 µin).</p> |
| Procedure Qualification Testing | <p><u>General</u> The thermal spray procedure shall be supported by a qualification test and the following essential variables shall apply to each procedure:</p> <ul style="list-style-type: none"> - the type of equipment used; - nozzle length; - fuel and gas flow rate, ±5 %; - spray distance, ±5 %; - spray rate, ±5 %; - grade of powder; - powder supplier; - sealer type (if used). <p>The procedure shall be re-qualified if any of the above is changed outside given allowable range. The qualification test shall be made at test samples of sufficient size for extraction the required test specimens. Each procedure qualification shall be tested as specified in the following sections.</p> |

| Element Data Sheet | | EDS No. IH002 | Rev. 01 |
|---|---|---------------|---------|
| <i>Type of Special process: Hard facing by thermal spraying of tungsten carbide</i> | | | |
| Page 2 of 2 | | | |
| Procedure Qualification Testing | <p><u>Bonding test</u> The bonding strength shall be tested in accordance with ASTM C633 or ISO 4624. Not less than 3 specimens of a type shall be tested. Acceptance criteria: minimum bond strength shall be 60 MPa (8.7 ksi).</p> <p><u>Bending test</u> Three coupons, with size 20 mm x 100 mm x minimum 1.5 mm shall be tested. The coupons shall be bent 90° over a mandrel with diameter 25 mm (1.0 in). Acceptance criteria: no spalling is acceptable. However, cracking in the coating and chipping on the edge of the test specimen is acceptable.</p> <p><u>Hardness test</u> A minimum of 3 indentations shall be made on a cross section for metallographic examination. Acceptance criteria: The average hardness shall be minimum 1000HV0.3 with minimum single value not lower than 900HV0.3.</p> <p><u>Porosity test</u> One piece shall be prepared for cross section metallographic examination. An area of minimum 1.0 mm² shall be examined. Acceptance criteria: the porosity shall be less than 1 % by area.</p> <p><u>Surface finish test</u> The surface roughness of the finished component shall be tested. Acceptance criteria: The roughness value shall be Ra ≤ 0.15 μm (6 μin).</p> | | |
| Production Testing | <p>Finished polished hard facing thickness and surface roughness of all parts shall be tested and shall fulfil the requirements specified above.</p> <p>Production testing shall be carried out on regular basis as minimum twice per week and on every new batch of powder or on changing grade of powder. The test shall be similar to a procedure qualification test and the applicable testing shall consist of hardness and porosity test according to the requirements stated above in the EDS.</p> | | |

| Element Data Sheet | | EDS No. IH004 | Rev. 01 |
|--|--|---------------|---------|
| Type of Special process: Electroless Nickel Coating | | | |
| Page 1 of 1 | | | |
| Scope | This EDS specifies additional requirements to the referenced standard for hard facing for electroless nickel coating for valve trim components intended for severe service and wear applications. | | |
| Reference Standard | ASTM B733 The coating shall comply with type V (10 % P), service condition SC4 and heat treatment Class 2. | | |
| Process | <p><u>General</u> Stabilizers used in the plating bath shall be basically organic stabilisers and shall be free of cadmium, bismuth and sulphur. Lead may be present but at a maximum concentration of 2 mg/kg (2 ppm by mass). Peening shall not be applied.</p> <p><u>Surface preparation</u> The support surface shall be prepared by abrasive blasting to SA 3. The roughness shall be: – For round shape surfaces: Rt ≤ 2 µm (79 µin) and Ra ≤ 0.4 µm (16 µin). – For other surfaces: Rt ≤ 60 µm (2360 µin) and Ra ≤ 12.5 µm (490 µin).</p> | | |
| Heat Treatment | Heat treatment to Class 2 shall be applied in inert atmosphere. | | |
| Production Testing | <p><u>Hardness test</u> The hardness of the plating shall be measured using the Knoop method in accordance with ASTM B578. The hardness shall be within the range of 800HK100 to 900HK100.</p> <p><u>Adhesion tests</u> To ensure satisfactory adhesion of the coating a bend tests to ASTM B733 and B571 and an impact test to B733 shall be carried out.</p> <p><u>Alloy composition</u> A chemical analysis shall be carried out to verify the composition of the coating. The phosphorus content shall be within 9 % to 11 % by mass balanced with nickel and maximum 0.05 % other elements.</p> <p><u>Porosity</u> A ferroxyl test to B733 shall be carried out. The coating shall be free of pores, cracks or other through-thickness imperfections.</p> | | |
| Test Sampling | <p>Sampling for non-destructive testing shall be carried out in accordance with ASTM B602, Table 1, Level I. Sampling for destructive testing shall be carried out in accordance with ASTM B602, Table 4.</p> <p>Test coupons of the base material plated simultaneously in the same bath may be used as an alternative to testing of actual article to comply with the required tests.</p> | | |
| Non-Destructive Testing | <p>Acceptance requirements for coating as applied to articles shall comply with ASTM B733 section 7. The sampling for testing shall as specified above.</p> <p><u>Visual Inspection</u> All components shall be examined. Coating shall be smooth, adherent and free from visible blisters, pits, nodules, porosity and other defects. Slight discoloration resulting from heat treatment shall not be cause for rejection.</p> <p><u>Thickness</u> Plating thickness shall be checked by the magnetic method as described in ASTM B499 (this method is only suitable for use with magnetic substrates).</p> | | |

| Element Data Sheet | | EDS No. IH005 | Rev. 01 |
|---|--|---------------|---------|
| Type of Special process: Solid tungsten carbide material | | | |
| Page 1 of 1 | | | |
| Scope | This EDS specifies requirements for solid tungsten carbide for use in piping and valves parts. | | |
| Composition | <p>The binder shall be of Co or Ni base.</p> <p>Co base materials shall be alloyed with Cr and Ni or Cr, Ni and Mo to be corrosion resistant in well stream service.</p> <p>Ni base materials shall be alloyed with Cr or Cr and Mo.</p> <p>Ceramic materials may be used subject to purchaser approval.</p> | | |
| Process | <p>The material shall be produced by sintering with a subsequent hot isostatic pressing (HIP) or produced by a combined sinter/HIP process.</p> <p>The manufacturer shall establish detailed manufacturing procedure to ensure that the requirements of this EDS are satisfied. The manufacturing procedures shall include tolerances on all essential variables.</p> | | |
| Production Testing | <p><u>Hardness test</u></p> <p>The minimum hardness shall be 1600HV30, measured by the Vickers method according to ISO 3878.</p> <p><u>Fracture toughness</u></p> <p>The fracture toughness shall be minimum $W = 9.5 \text{ MNm}^{-3/2}$ measured by the Palmqvist (Vickers indentation – crack length) method according to ISO 28079.</p> <p><u>Metallographic examination</u></p> <p>The WC grain size shall be of type “Fine” or smaller measured according to ISO 4499-2.</p> <p>The carbides shall be homogeneously distributed in the binder phase.</p> <p>No eta-phase (η-phase) shall be present, and porosity/uncombined carbon levels shall be $\leq \text{A02/B00/C00}$ according to ISO 4499-4.</p> | | |
| Extent of Testing | Testing shall be performed on one sample per powder batch and HIP batch. | | |
| Non-Destructive Testing | <p><u>Visual Inspection</u></p> <p>All components shall be examined and be free from visible porosity, cracks and other defects.</p> <p><u>Liquid penetrant testing</u></p> <p>Fluorescent penetrant testing shall be performed according to ISO 3452 or ASTM E165 on each component after final grinding/polishing to confirm that the material is free from any surface indication. 100 % of all accessible internal and external surfaces shall be examined.</p> | | |

| Element Data Sheet | | EDS No. IO001 | Rev. 01 |
|---|--|---------------|---------|
| Type of Special process: Alloy 625 corrosion resistant overlay welding | | | |
| Page 1 of 2 | | | |
| Scope | This EDS specifies requirements for corrosion resistant overlay welding for piping and valve parts. | | |
| Welding | <p><u>Welding process</u></p> <p>Slag-forming welding processes are not permitted for overlay welding of sealing surfaces.</p> <p>A minimum of two layers of weld metal shall be deposited for all processes, while only one layer is acceptable for the electro slag weld process.</p> <p>Thickness of the overlay deposit for corrosion protection after final machining shall be minimum 3.0 mm or as required on applicable design drawing.</p> <p><u>Welding Consumable</u></p> <p>The welding consumable for the weld overlay shall comply with UNS N06625.</p> <p><u>Welders, operators qualification</u></p> <p>The welder or welding operators shall be qualified to ASME IX, ISO 9606 or ISO 14732.</p> | | |
| Procedure Qualification Testing | <p><u>General</u></p> <p>The welding procedures shall be qualified in accordance with ASME IX or ISO 15614-7, modified as follows. The weld qualification test shall be carried out on base material of same grade as to be used in production. Qualification testing shall be carried out according to ASME IX or ISO 15614-7 and the following additional requirements.</p> <p><u>Chemical composition</u></p> <p>The weld overlay deposit shall comply with UNS N06625 with a maximum iron content of 10 % by mass measured at the minimum qualified thickness, unless a lower value of 5 % iron by mass is specified by the purchaser.</p> <p><u>Hardness testing</u></p> <p>Hardness testing shall be carried out on base material, heat affected zone and weld metal. Vickers hardness HV5 or HV10 shall be used. The examination of the HAZ shall be carried out with maximum 0.5 mm (0.02 in) distance between the indentations from fusion line, through HAZ into the unaffected base material.</p> <p>Testing of HAZ shall be carried out with maximum 0.5 mm (0.02 in) distance between the indentations from fusion line, through HAZ into unaffected base material. The hardness for HAZ and unaffected base material shall not exceed 350 HV.</p> <p>When sour service is specified by the purchaser, the hardness of the weld overlay, HAZ and unaffected base material shall not exceed the maximum values specified in ISO 15156 /NACE MR0175 or ISO 17945 /NACE MR0103. The hardness of finished machined overlay surface shall not exceed 35 HRC for Alloy 625.</p> | | |
| Heat Treatment | Heat treatment after overlay welding shall be carried out, as necessary, to meet specified properties | | |
| Non-Destructive Testing | <p><u>Visual Inspection</u></p> <p>VT shall be carried out on each 100 % of the weld overlay according to ASME BPVC Sec. V, Article 9 or ISO 17637. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be cleaned prior to the testing. Porosity, slag inclusions are not permitted on and within 50 mm (2 in) of sealing surfaces.</p> <p><u>Liquid penetrant testing</u></p> <p>All deposited surfaces shall, after final machining, be penetrant tested in accordance with ASME V Article 6 with acceptance criteria according to ASME VIII, Div. 1, Appendix 8, except on sealing surfaces where no indication is acceptable.</p> <p><u>Thickness of weld overlay</u></p> <p>The weld overlay thickness shall be measured at minimum three locations for each component. For components with complicated geometry the manufacturer shall establish a procedure for this purpose.</p> | | |

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| Element Data Sheet | EDS No. IO001 | Rev. 01 |
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Type of Special process: Alloy 625 corrosion resistant overlay welding

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|---------------------------------|---|
| <i>Repair of Defects</i> | <p>Repairs may be local or total when non-conforming conditions are found. Defects in excess of acceptance standard shall be removed by reducing weld overlay thickness and shall be repaired by re-welding.</p> <p>All excavations shall be dye penetrant inspected prior to the start of repair welding in order to confirm the complete removal of defects.</p> <p>Repair by re-welding shall be performed in accordance with a written procedure. The following information must be given in these procedures:</p> <ul style="list-style-type: none"> - Method of removing defects; - Requirements related to the shape of the excavation; - Inspection of repair prior to re-welding; - Applicable welding procedure and qualification tests; - Inspection after welding. |
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Bibliography

- [1] ASME B31.3, Process Piping

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